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THE AMERICAN
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EDITORIAL

BONERS

A PROFESSIONAL humorist is a sad individual as compared with a pupil who uses or defines words of whose meaning he is ignorant.

The Viking Press, a few years ago, with the assistance of Doctor Seuss, gave to the world several volumes of "gems" in the shape of assorted misinformation as contributed by pupils of various grades and ages.

It is doubtful whether any of the published examples can surpass this naive explanation of the action of a single beam equal arm balance as reported on a freshman examination sheet a year or so ago—"After osculation it comes to rest with the arms parallel."

But there have been others almost as good. For instance there was the student who defined cylindrical as "a round horizontal sided vessel" and gave as an example "the dish is very cylindrical"; or the classmate who stated that "the cylindrical funnel was used."

The word "spontaneous" is a stumbling block to many young people. One said "spontaneous means occurring at the same time"; another defined it as "the combusting of anything that has an affinity for one another"; still another said "easily mixing—as tartaric acid and water," while many defined it as "something that takes place suddenly."

The word oscillate is fatal in a fairly large proportion of cases. One says "oscillate means to rotate," which shows at least a comprehension of the fact that motion is involved, but one wonders where in the world the following came from: "Oscillate means taken away from." Example: "The good is oscillated from the bad," while still another makes the statement "the scissors oscillate freely."

One is also at a loss to explain the following definition of fusion: "Making a buzzing noise." Example: "The string was effected by fusion." Another example without a definition was "The fusion was very quickly." Still another, "Fusion—the drying out of a drug to make it more pliable."

The hydrometer is frequently confused with other physical instruments as in the following: "People who go up in ballons always use hydrometers."

"Meniscus" is of course a purely technical word but it is not "a substance which is missable with water."

Sometimes the definitions are short as well as incorrect, as in the following:

Concise—to reduce.
Concrete—united in growth.
Mobile—irregular.
Immunize—sterile.
Identification—to indify.

Superimpose brought forth the following choice assortment: "to overdo"; "to change about"; "to overcharge"; "having more force"; "abnormal"; "to confirm."

There is cleverness in the answer in which an "alembic" is defined as "a kind of apparatus," and the accompanying example—"The alembic was broken."

"Vacuum" is a term that is frequently misdefined but rarely better than in "something which contains nothing."

The teacher in pharmacy becomes thoroughly accustomed to the confusion of Jupiter and juniper, just as the teacher in medicine becomes inured to the transformation of Hippocratic to hypocritic. But the teacher who has the most fun of all is the one who asks the student to draw a sketch of a certain specified form of apparatus, or who, having furnished an outline of the human body, asks the student to properly locate the clavicle, duodendum, thyroid, etc.

Is it any wonder that the "professor" needs a summer vacation while next year's classes are accumulating some new and varied kinds of misinformation?

C. H. L.

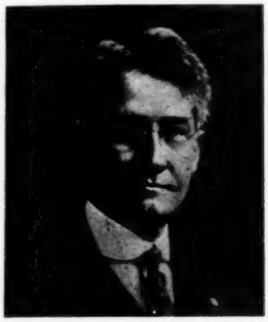
ORIGINAL ARTICLES

THE HISTORY AND ROMANCE OF BREAD

By Charles H. LaWall, Ph. M., D. Sc.

Dean of Pharmacy of the Philadelphia College of Pharmacy and Science; Chemist to Bureau of Foods and Chemistry, Pennsylvania Department of Agriculture, and Analytical and Consulting Chemist.

THERE are many ways in which we might approach the subject of tonight's lecture, keeping in mind Kipling's line, "There are nine and sixty ways of constructing tribal lays, and every single one of them is right."



Charles H. LaWall, Ph. D., Sc.D.

We might, for example, start with the story of the young home economics student, who, after the lesson on bread making, announced that when she went to housekeeping she would always bake her own bread, for, as she explained, "The kneading of the dough makes one's hands so clean and white."

We might start with a discussion of Alfred the cake burner or remind you how the ill-fated Marie Antoinette lost her head twice—once when she asked why the starving mobs did not eat cake when she was told that they were clamoring for bread, and once again when she gave Madame LaFarge an opportunity to make a final entry in her knitting registry—but both of these tales are apocryphal and will not serve for a proper introduction.

We might moralize over the fact that the expression "bread and cheese and kisses" is intended to convey an idea of the basic necessities of life expressed in the simplest terms.

We might begin with a quotation regarding bread, such as "Better is half a loaf than no bread," or mention "the bread of idleness" or what happens to "bread cast upon the waters," which is the earliest reference to "dunking," by the way.

After studying all these possibilities we shall reject all but the last and use that plan when we can decide upon the proper quotation, and behold, here it is: "Two things only the people anxiously desire, bread and the circus games."

BREAD AND CIRCUSES

When Juvenal wrote the famous satire in which *panem et circenses* achieved immortality, the Roman emperor Trajan was just beginning the reign under which the empire was to attain its greatest power and extent; Tacitus the historian was consulting the ancient records; Plutarch was making a vogue for biography, and Pliny was beginning his plagiaristic career. Food and amusements were furnished free of charge to "citizens and slaves" in the days when Rome was beginning to become top heavy. As the federalization of cabarets is not yet in sight we may be in a safer position than some of the economists believe.

The bread mentioned by Juvenal was probably wheat bread, but whether it was leavened or unleavened is an open question. The Latin word *panis,* meaning bread, was derived from the name of the deity who presided over pastures, forests and flocks—none other than "the great god Pan"—and the word "panary" has been applied as an adjective meaning pertaining to the art of bread making, as in "panary fermentation."

More than a thousand years before the time of Juvenal a certain Hebrew song writer had mentioned bread in another immortal paragraph: "Wine that maketh glad the heart of man, and oil to make his face to shine, and bread which strengtheneth man's heart." And this verse waited nearly two thousand years for the Biblical commentator, Matthew Henry, to transpose the thought and give us the expression "the staff of life"—"Here is bread which strengtheneth man's heart and therefore called the staff of life"—which was soon after appropriated by Dean Swift and used in his "Tale of a Tub," from which source the expression gained wide circulation.

The ancient Egyptians, long before the days of Rameses and "King Tut," had devoted their agricultural activities principally to raising spelt (an early variety of wheat) and barley, and the predominance of these two crops continued down to Alexandrian times and is confirmed by the records of the Ptolemies.

"Spelt they used for bread and barley they used for beer." Need more be said concerning man's primitive needs, especially when we realize that the words "bread" and "brew" have a common etymological root. Many centuries later a well-known Persian poet added a certain type of mental food to these physical needs:

"A book of verses underneath the bough,
A jug of wine, a loaf of bread, and thou
Singing beside me in the wilderness;
O wilderness were Paradise enow."

The Jewish patriarchs were familiar with both leavened and unleavened bread, although the punitive phrase, "In the sweat of thy brow shalt thou eat thy bread," is not explicit as to which kind is meant. Certain it is, however, that when Abraham entertained the angels and told Sarah to "make ready quickly three measures of fine meal and knead it and make cakes upon the hearth," there was no time to use leaven, and this was nearly 4000 years before baking powder was invented.

Also when Lot entertained another group of angels sometime later, it is specifically stated that "he made them a feast and did bake unleavened bread and they did eat."

JOSEPH'S CORNER IN WHEAT

In all probability this unleavened bread was made from barley meal, for wheat was a luxury that came from Egypt, which was the granary of the world for many centuries. Do you not remember the famous corner in grain engineered by a certain Joseph who "gathered corn as the sand of the sea for seven years"? It is interesting in this connection to note that it was the interpretation of the dreams of the baker and the butler that attracted the attention of Pharaoh to Joseph and brought about his advancement. If Joseph had been a Freudian the subsequent history of the Jewish race might have been very different.

The Egyptians were acquainted with the art of making both leavened and unleavened bread at this time and probably taught it to the Hebrews, for after the Exodus we find many references in the Bible to both leavened and unleavened bread, although the Israelites could not have been blamed for forgetting the technique of bread making during the forty years in which manna took its place. In Exodus xii, 15, we find the following passage in connection with the observance of the passover: "Seven days shall ye eat unleavened bread, even the first day shall ye put away leaven out of your houses, for whosoever eateth leavened bread from the first day until the seventh day, that soul shall be cut off from Israel."

The origin and true explanation of some of the Jewish customs concerning bread and leaven, such as the foregoing one, are still in doubt. Why was leavened bread forbidden during the Passover? Why was it forbidden even to have leaven in the house? Was the shew bread placed on the altar for the priests leavened or unleavened? We are certain of one thing—that bread—using the term in its broadest sense, has been the principal food of man from prehistoric times.

EARLY BREAD MAKERS

The Swiss lake dwellers crushed their barley and an early and inferior variety of wheat in a crude stone mortal with a stone pestle.

Other substances than grain, such as beechnuts and acorns were used by primitive man for making bread and it is quite possible that the earliest "loaves" were sun-dried instead of being cooked with fire. It is also likely that the first method of cooking with fire was accomplished by the employment of heated stones or of hot ashes, which methods are still used by primitive peoples and by campers. Bread-making was at first a household art, then it developed into a community custom and finally there was evolved the indispensable social factor called the baker. All of these stages are still in existence simultaneously at the present time.

In the ruins of ancient Chaldean buildings there was an oven in the courtyard of every home, and the grinding stones for milling the flour were usually located nearby. In ancient Egypt it is that we find the art of baking first carried to a fairly high degree of advancement. The natives of the Nile country used wheat, spelt, barley or durra (also called millet or sorghum). Even in these early centuries of the Pharaohs of the pyramids, white bread was preferred, and being more costly was a luxury eaten principally by the wealthy.

In confirmation of the statement that the Egyptians knew the art of making leavened bread and used yeast at a very early period, loaves of porous bread found in tombs uncovered during archaeological research, upon close microscopic examination have revealed the presence of dead yeast cells.

Here we might pause for a moment and speculate to advantage upon the accuracy of modern scientific methods which aid us in reconstructing events of the past with a certainty that is almost uncanny at times.

But to resume. Herodotus says of the Egyptians of his time that they kneaded clay with their hands and dough with their feet. Scotch bakers are said to have followed this custom until very recent times. Perhaps the purpose here was to see that the employee was kept busy with his hands while he was kneading dough with his feet so as to get double the amount of work out of him.

Travelers in modern Egypt tell us that the ambition of the Egyptian baker of the twentieth century is to get the biggest possible loaf out of the smallest possible amount of flour, with the result that the bread of the Nile valley is usually a hole wrapped in a crust. The

dough is rolled out like pie crust, the edges are joined and the oven heat puffs the mass up like a balloon.

About 2800 B. C. the Emperor Chin Nung is said to have taught the Chinese the art of husbandry and also the methods of making bread from wheat and "wine" from rice.

CERES AND THE CEREALS

It was in the time of classic Greece that Ceres presided over agriculture. She was the daughter of Saturn and Rhea, and the mother of Proserpine, queen of the Plutonian realms. Her especial harvests were the cereals —the seeds of the "grasses." In our modern classification this places wheat, barley, rye, rice, oats, maize, and millet in the group of cereals, while the legumes such as beans, peas, and soy, and buckwheat, which belongs to the dock family, are not cereals at all. Ceres herself probably partook of "ambrosia," the traditional food of the gods, which was said to be nine times sweeter than honey. Nowadays one does not have to be an Olympian to partake of a substance that is *thirty times as sweet as ambrosia;* one has merely to be a diabetic.

There has been some argument as to whether Ceres or Miletus should be given the honor of having invented millstones. In Rome the goddess Mola looked after mills, millers and bread, while in Greece Mercury was given this responsibility, and as he was, in addition to being the Olympian messenger, the god of thieves, merchants and orators, he must have been kept fairly busy. The goddess Fornax was at one time officially selected by the Roman Senate for the patronage of bakers, who preferred to sacrifice to the goddess Vesta, it is said.

The Greek bakers must have been influenced but slightly by mythological traditions for they are said to have developed fifty varieties of bread, which is probably an exaggeration, although Athenaeus, the accepted authority on Greek customs and Greek cookery minutely describes many kinds of bread which were current in second century Greece. A tradition of ancient Greece explaining the origin of leavened bread (which had been made centuries previously by the Egyptians) is essentially as follows:

The slave of a prominent citizen of Athens had left some wheaten dough in an earthen vessel and had forgotten it; later he found the dough much changed in appearance and full of bubbles, but, instead of throwing it away, he mixed it with some fresh dough. The resulting bread was porous, light in texture and delicious in flavor.

The slave had accidentally discovered leavened bread through the infection of the sponge with wild yeast cells. The householder summoned the slave, who revealed the secret. In a short time the baking of leavened bread became quite general in the neighborhood, and Athenian bread gained a reputation all over Greece.

Bread baking in Rome was not as important a factor as it was in Greece until after the Roman conquest of Macedonia, when Greek bakers emigrated to Rome in considerable numbers. The Romans soon thereafter developed the custom of having public ovens for community use, and the ovens of the individual householders began to disappear. The public ovens soon became to the people of Rome what the barber shops are to the small towns of today—clearing houses for community gossip.

In the ruins of Pompeii some private homes have bakehouses and mills in the courtyard like the homes of the early Babylonians, but as evidence of the obsolescence of "homemade bread" they have also found evidences of public bakers who were required to have their individual insignia stamped on each loaf. According to Pliny, public bakers came into community life toward the close of the second century B. C. By the time of Trajan a college of bakers was organized, but—it was an association of employers and not of operatives.

Doran, in "Table Traits" says that endless varieties of bread were sold in the Roman markets in later times—Cappadocian bread for the wealthy, "pugilistic" loaves for the athletes, batter bread for strong stomachs, and that bread poultices were worn by the Roman debutantes and matrons at night for the preservation of the complexion.

EARLY BREAD LAWS IN ENGLAND

In the Middle Ages bakers were subject to regulations throughout Europe. In England, for example, the first parliamentary act regulating the price of bread was passed in 1266, and this act continued in operation until 1822 in London and until 1836 for the rest of Great Britain. The preliminary stages of this legislation were developed during the reign of John (1203), which provided for "legal obligations of assize as regards bread," and the later legislation which protected the public from the dishonest dealings of bakers, vintners, brewers, and butchers, was called the "pillory and tumbril" act. The English are certainly not an impulsive people as regards legislation. Conservatism of this kind is sometimes a good thing.

But before beginning to moralize on the subject let us see what this legislation prescribed and proscribed. We find that the acts not only regulated the price but also the size of the loaf. How this was done so as to be effective over a long period of time will be explained later. The act was amplified and emphasized by subsequent legislation but was never changed in its essential features. Let us quote from the *Liber Albus* issued in the reign of Edward I in the latter part of the thirteenth century:

> "If any default be found in the bread of a baker in the city, the first time let him be drawn upon a hurdle from the Guildhall to his own house through the great streets where the most people are assembled and through the great streets which are most dirty, with the faulty loaf hanging round his neck; if a second time he shall be found committing the same offense let him be drawn from the Guildhall through the great street of Cheepe in the manner aforesaid to the pillory and there remain at least one hour in the day, and the third time that such default shall be found he shall be drawn, and the oven shall be pulled down and the baker made to forswear the trade in the city forever."

The earlier legislation referred to was even more unpleasant in the punishment directed, for brewers and bakers when found guilty of breaking the laws relating to their trades were tied fast in what the Doomsday Book called the *"cathedra stercoralis"* and ducked in the stinking contents of a cesspool.

Pre-Elizabethan England was a meat-eating England, according to Frederick Hackwood, in his "Good Cheer." Green vegetables were scarce, and yet, strange to say, bread consumption was lower than in Continental Europe. England even exported wheat until the middle of the eighteenth century, while the Scotch were developing a liking for oatmeal and furnishing the data for Dr. Samuel Johnson's celebrated definition of oats in the first edition of his dictionary. Even so, bread was still the "staff of life," and a "shive," as a slice of bread was called in those early days, was often used as a trencher or substitute for a plate, which had some advantages from the dishwasher's standpoint.

There were many curious regulations governing the bakery practice of England, which was typical of the European countries. Bread was graded according to the fineness of the flour. The finest and whitest bread was known as simnel bread or *pain demayn,* from *Panis*

Dominicus, the Lord's bread, because upon each loaf was impressed a figure of the Saviour. Only the wealthy could afford this bread.

The second quality was "wastel bread," used by the more prosperous members of the middle class, the name also coming from the French, which, it must be remembered, was the official language of Norman England. Next came a slightly inferior quality called "lightbread," "French bread" or "puffe."

Still lower in the scale came a bread called "cocket," which bore a special seal or mark of identity. A shade lower than this was "tourte," a twisted bread in general use among the poorer people and in the monasteries. Continuing the descent, we next find "trete" bread or "bis," which was a brown bread made from ground wheat from which the finer flour had been removed by sifting for use in one of the better varieties of bread. Then came "black bread," corresponding to the "schwartzbrod" and "pumpernickel" of the Teutonic countries, and finally, the bottom was reached in "horse bread," of which the principal farinaceous ingredients were beans and peas.

The nomenclature was in reality much more complicated than this, for small round loaves were called "obleys," while "cracknels" were small crisp biscuits of special composition. "Manchet" was white bread for the master's table, while "chete" was made from unbolted flour, and "mystelon" was made from a mixture of flour and rye meal. What a fine list of crossword puzzle words, which seem to have been overlooked!

This all sounds very complicated and very discouraging, for remember this was in the days when laws were laws, and not "gestures" or "noble experiments." But let us look at some of the subsidiary regulations:

1. The baker of white bread was not permitted to bake either tourte or trete, and was not even permitted to possess a bolting sieve.

2. Innkeepers were not permitted to bake their own bread.

3. In London only farthing loaves and halfpenny loaves were permitted to be made and each baker was required to stamp the loaf with an identifying symbol.

4. In markets loaves were displayed in "pannyers" or bread baskets on Tuesdays and Saturdays, each basket paying a tax of a halfpenny.

5. If the bread was distributed by women carriers, who sometimes peddled it from house to house, these distributors were privileged

to purchase from the bakers and received thirteen loaves for each twelve paid for, this being intended for the distributor's sole profit. This is the origin of the expression "a baker's dozen," for thirteen.

Magistrates had the right to search a baker's premises and if any adulterant was found a seizure was made of the entire stock of the baker. Sometimes the penalty also included a public flogging of the offender. The term "bred-wite" was used in Saxon times to designate the penalty imposed for defaults in connection with bread taxes and returns. At one period wheat bread was required to be marked with a W, and bread of lower grade was called "household bread" and was marked with the initial H. Bread made from other grains than wheat had to be marked as the justices might require. A cross "X" was the symbol designating bread made from mixed ingredients—a truly unknown quantity, gastronomically as well as mathematically.

These laws and regulations were, of course, in the interest of the bread consumer. They had the effect of forcing the bakers into associations or "gilds" in Europe. In England the bakers' gild was founded in 1155 and incorporated in 1307, at which time there were two separate "companies," one for the baking of white bread and one for the baking of brown. These separate gilds continued until the seventeenth century.

PIGS KEPT IN BAKERIES

In the very earliest days of bread regulations the bakers were not permitted to sell at retail from their shops, but as a sort of compensation they were the only community group that were permitted to keep swine in their houses. This was for the purpose of promoting the speedy consumption of bran and other bakery waste, and also to relieve the baker from any temptation to make his bread too coarse. The proviso was added that "the pigs must be kept out of streets and lanes," How would pigsty-made bread appeal to the lovers of "home-made" bread of the present time.

About this same time the monastery ovens were baking a number of prescribed loaves, designated as follows:

1. *Panis armigerorum,* for the abbots' guests and visitors of distinction.

2. *Panis conventualis,* an inferior quality for the brethren of the order.

3. *Panis puerorum,* for the boys of the cloister and the school.

4. *Panis famulorum,* for the servants of the monastery.

In the *Liber Niger*, "a collection of ordinances and regulations for the government of the royal household made in divers reigns," it is stated that during the reign of Edward IV (1461-1483) the "King had for his brekefast, two looves made into four mannchettes and two payne demain." The "bakehouse" regulations during this same reign required it "to make a bushell of flower 30 loves by a commyn boulter, thorowe all the house, every loafe weying 30 ounces, and no black brede but for the trenchours or houndes."

For many centuries during which these regulations and customs were effective, weekly returns were required to be made to the proper authorities by millers, grain dealers, and bakers. Until the time of *Georgius Tertius*, there was a "cocket" office in the mansion house in London where bakers within a radius of ten miles of the Royal Exchange had to make weekly returns of bread and meal before 5 P. M. on Saturdays.

By the time of Henry VIII (1509-1547) the bakehouse regulations required that the "Sergeant of the Bake House doe see that the bakers doe bulte the Branne clene, that there be found noe wast therein; and that the Furnour doe season the bread well, not drowning it with too much water, weighing the same into the oven, that every Loafe may weigh and keepe its full weight, after it is baked as it ought to bee, and that the bread be not rashly handled in drawing it out of the Oven, nor in putting it into the Storehouse, for fear of breaking of the Bread, whereby there shall come wast; also that he look that no officer be wastfull in giving of the King's Bread away." King Hal was more solicitous of his loaves than of his loves.

In Queen Elizabeth's reign we find the following interesting item concerning the Bakehouse Sergeant:

> "His entertainment 11£, 8s, 2½d. a yeare and 16d. a day board wages; he hath the brane of all the meale spent in the great bakehouse for his fee, and is to answer all the lavish expences, all losses, wastes and filchings within his office."

REGULATING BREAD PRICES BY A SIMPLE RULE

Now here is the way in which they adjusted the price of bread to the cost of materials over this period of more than half a millenium. The price of the finished loaf was adjusted to the cost of flour and adjustments were made upward or downward for each variation of threepence per bushel in the market price of wheat. To give one an idea of the cost of bread in England, in the early

twelfth century, long before legislation was directed toward the control of the quality and price of bread, it is recorded that in the time of Henry I, a measure of wheat sufficient to make bread for one hundred men tor one day, was valued at one shilling.

By the time of William and Mary, at the end of the seventeenth century, the cost of bread was considerably higher and wheat went mostly to the larger towns and cities, while the rural proletariat subsisted mainly on barley bread, rye bread, and oat cake. A study of the cost of bread to the consumer during the period from 1735 until 1892 in England, showed the lowest price to have been reached in 1745, when the price of a quartern loaf (four pounds in weight) was four and three-fourths pence, while in 1800 the same sized loaf commanded twenty-two and one-half pence.

Regulations based on the earlier laws continued to multiply during the eighteenth century in England. In 1773 it was decreed that "the standard wheaten bread should weigh three-fourths of the wheat whereof made, and shall be marked SW." It was also required that the "peck loaf" must weigh 17 lbs. 6 oz. av., and lesser loaves in proportion. Seven standard loaves were calculated to be equivalent to eight wheaten loaves and six household loaves.

By 1790 the law permitted bread to be made of wheat with a deduction of only five pounds of bran per bushel, or to be mixed with other grain or potatoes, and to be sold at reasonable prices.

During this century the majority of English farmers still ate "barley bread," made from wheat and barley, or "blencorn bread," made from rye and barley. Meat at two and a half pence a pound was still a high-priced luxury for the laboring classes. One record of an eighteenth century well-to-do family shows a total consumption of only a peck of wheat for an entire year, and that was mainly at Christmas. The principal diet was "barley bread," oatmeal, a few vegetables, and, rarely, bacon.

At the beginning of the nineteenth century England was on the brink of famine, due to war and bad harvests. A royal proclamation exhorted economy. The noble and wealthy discouraged the use of pastry, and a movement to encourage the eating of brown bread instead of white bread was begun. A law was enacted prohibiting the sale of bread until it had been out of the oven for twenty-four hours. A royal grant was made to an individual who was supposed to have discovered a substitute for flour. Bounties were paid for the importation of maize and rice. A law was passed forbidding altogether the

manufacture of bread from white flour and providing that all bread should be made from whole wheat flour.

All of these legislative efforts to regulate the quality of bread at this time were futile. The English citizens wanted white bread and wanted it fresh. Laws in all time and in all climes have failed of enforcement when they have opposed the popular will. During this same difficult period it is stated that the ship's biscuits served to the sailors in the British Navy were so full of weevils that when the inhabitants were ejected by knocking the biscuits on the table there remained only the hollow crusts. Conditions during these corresponding periods in Continental Europe almost paralleled those in England.

SEVERE PUNISHMENTS FOR BAKERS

The conditions in Turkey during the eighteenth century were particularly trying for the bakers. If wheat became scarce, owing to famine, and the bread price was raised by the bakers, the authorities would hang a baker or two as a deterrent to any further rise in price. A lighter penalty occasionally inflicted in Turkey and also in Egypt for adulterated or short-weight bread was to nail the offender by the ear to the doorpost of his bakeshop. Even at that they were more fortunate than Persian bakers, who in recent times were baked in their own ovens for raising the price of bread.

The present English bread law goes to the opposite extreme, for at present "it is lawful to make and sell bread made of flour or meal of wheat, barley, rye, oats, buckwheat, Indian corn, peas, beans, rice or potatoes with common salt, pure water, eggs, milk, barm, leaven, potato or other yeast, and mixed in such proportions as they shall think fit and with no other ingredients or matter whatsoever."

We shall now turn our attention to the chemistry of bread.

THE CHEMISTRY OF BREAD MAKING

Some years ago I wrote a twenty-page monograph upon this subject. Those who wish further details than I shall give here may consult the original article, although I shall endeavor to epitomize the essential facts at this time.

The classification of bread into leavened and unleavened affords a sharp distinction as a starting point. In the making of unleavened bread the obvious chemical changes are of minor importance and are confined to the modifications and transformations of the starch during the process of baking. Thus, if a fairly high baking temperature is

applied, as is frequently seen in the so-called "Krisp" breads, a small amount of the starch is converted into dextrin, making the product more palatable and more readily digestible. In the lightly baked matzoth or Jewish Passover bread, however, the chemical changes are at a minimum, although the swelling of the starch grains in the initial stages of the baking cause physical changes which make the starch more easily digestible.

In leavened bread, however, we are confronted by a variety of possibilities. In the first place, we must not ignore the fact that leavened bread, in its simplest form, contains shortening (fat) and seasoning (salt) in addition to the leavening factor, and that we may also find sugar, milk, malt extract, yeast foods, etc., which complicate the problem immensely from the standpoint of all of the chemical changes involved. The identity of the cereals used is of less importance in connection with the chemistry of bread making than with its physical texture and palatability. For the purpose of the present discourse we shall ignore all chemical changes except those connected with the vesiculation or leavening of the bread.

We have spoken previously, in a general way and but briefly, of the cereals and other farinaceous materials used in bread making. The four great food staples of the world at present are wheat, potatoes, rice, and dasheen, and from but one of these—wheat—can vesiculated bread be made. Of these four, wheat has the greatest climatic range. It grows from Patagonia to Hudson's Bay in the western hemisphere, although in latitudes beyond 60 degrees it requires ninety days from seed time to harvest.

I am using the word "vesiculated" purposely in this connection because it is a broader term than "leavened," which presupposes the presence of a ferment like yeast, and, as we shall presently learn, porosity or vesiculation of the dough may be produced by physical or chemical means entirely independent of and different in principle from leavening with the aid of yeast.

Of these four staple "breadstuffs," as they may properly be called, two of them, wheat and potatoes, are used in the Occident, while the other two, rice and dasheen, furnish the major calorific requirements of the Orient. The auxiliary staple foodstuffs are barley and rye, used principally in northern Europe; maize, used in the United States; millet (also called sorghum and durra), consumed largely in southern Europe and northern Africa, also to a large extent in some Oriental countries; buckwheat, employed in Russia and some other European

countries, as well as in America to a certain extent; cassava (tapioca), cultivated most extensively in the East and West Indies and in South America; and the legumes (peas and beans, including soy), which are used almost universally, soy being an important factor in China and Japan.

The story of the origins, distributions, and uses of these important foods would provide sufficient material for another lecture, so we must return at this point to our main subject, with this important declaration: of all the food materials mentioned so far, only wheat, barley, and rye are capable of making a true leavened bread with yeast. This peculiar quality is inherent in these true cereals by virtue of the presence of a distinctive and complex protein (nitrogenous) substance called gluten, which is a mixture of two other proteins called glutenin and gliadin.

Wheat, barley, and rye are the only cereals or farinaceous materials containing sufficient gluten to make a viscous dough. Wheat and barley flours stand highest in this respect, and rye flour next, while maize flour is very inferior, and in oats, millet and rice no gluten is found. In the non-cereal farinaceous foods such as potatoes, dasheen, buckwheat and the legumes, no gluten is present.

It is the tenacity of the gluten, when moistened, that enables the dough to hold the bubbles of gas and gives lightness to the bread. All country-raised youths have chewed whole wheat grains (being careful to avoid swallowing the solid portions) until a gummy, plastic mass resulted, which could be chewed indefinitely without diminution of elasticity. Even Will Rogers could go through a performance with a mouthful of "nature's chewing gum," as it is called. This elastic portion is the gluten.

Gluten undergoes little or no obvious change in bread baking. Its value resides particularly in its physical properties. I do not wish to create the impression that there are no chemical changes of importance. The changes that probably occur, obscure as they are, may be of profound importance and indispensable attributes to successful bread making. To put it plainly, we have conducted a large amount of physical and chemical research, but bread making is still an empiric art, to a certain extent.

We may classify vesiculated bread into three groups, as follows:

1. Breads that are made porous and light by physical methods.

2. Those in which the vesicularity (pardon the departure from the dictionary) is imparted by processes involving simple chemical reactions.

3. The breads that are leavened by means of ferments of an organized nature, involving biological changes which produce physical and chemical effects.

The method of aerating bread or making it light and porous by purely physical methods may be accomplished in several ways. These are all dependent upon the impregnation of the dough by means of a gas, which, upon kneading, becomes subdivided into minute bubbles. These bubbles, during the baking process, expand and bring about the vesiculation which is made permanent by the setting of the gluten during the baking process.

One of the earliest of these methods was that of Dr. Dauglish, an Englishman, who originated it in 1856. In his method carbon dioxide is the gas employed. In another and later method oxygen is used. There are several unusual methods in this group, in one of which snow crystals are mixed with the flour in sufficient amount to form a dough when they melt. They carry into the dough a considerable amount of air which gives a moderate degree of lightness. This method has been used by explorers and others in northern latitudes where yeast is unobtainable or conditions are unfavorable for its use.

Another unusual method of leavening bread is to mix a small amount of strong alcohol with the dough, which is then kneaded and placed in a warm atmosphere. The volatility of the alcohol creates bubbles of vapor that give lightness to the dough, which may then be quickly baked to make a fairly light bread. The alcohol escapes during the baking process, so there is no hope in this direction for those who may have their expectations raised by the mention of this process.

A border line method between the physical and the chemical is the use of hydrogen dioxide solution instead of plain water in making the dough. Each pint of dioxide solution is capable of yielding ten pints of oxygen, which upon expansion furnishes the vesiculating gas. It may be mentioned here, although it is not a part of the bread-making process, that the lightness of cakes and many other baked products is attained in a purely mechanical or physical manner by the use of egg white, which, upon being beaten to a stiff froth, entangles innumerable air bubbles that retain a certain degree of permanence due to the viscosity of the albumen. This froth, when mixed with dough or batter

and subsequently baked, carries in the necessary amount of gas (air) to give lightness to the finished product when baked.

It may be said, in passing, that the flavor of aerated bread, made by the processes just described, for the word "aerated" is applied to any method of making bread light without the use of yeast or baking powder, is markedly different from that of breads made by other methods. It is more or less insipid, due to its freedom from what might truthfully be called impurities or by-products found in breads made by chemical or biological leavening processes, which produce subtle but distinctive changes in flavor. One objection which has been raised to aerated bread is that, owing to its firm crust when freshly baked, it does not show staleness by the "feel" as ordinary bread does.

CHEMICAL METHODS OF PRODUCING VESICULATION OR LIGHTNESS

The methods of leavening which involve chemical changes are considerably older than the physical or mechanical methods just mentioned. They are employed on account of their convenience rather than for the sake of economy. None of the chemical methods is at present employed in making commercial bread on the large scale; they are usually employed in the home and then particularly for the extemporaneous preparation of biscuits or griddle cakes, both of which are forms of bread, using the word in its broadest sense.

The earliest chemical method of leavening, however, was really a large scale method, for it has never been successfully adapted to small scale production and cannot be prepared in baking powder form. It consists in adding baking soda and hydrochloric acid in such proportions as to exactly neutralize each other according to the following chemical reaction:

$$\underset{\text{hydrochloric acid}}{HCl} + \underset{\text{sodium carbonate}}{NaHCO_3} \longrightarrow \underset{\text{carbon dioxide}}{CO_2} + \underset{\text{sodium chloride (salt)}}{NaCl} + \underset{\text{water}}{H_2O}.$$

This is really the least objectionable of all of the chemical methods of leavening, for it produces a harmless gas (carbon dioxide) for developing the vesiculation, and the by-product of the reaction is common salt, which is always added anyway to season the dough and which might as well be added in this way. It is not a method suitable for home use, however, as it requires the services of a chemist to measure out the reacting substances in the proportions needed.

Another old-fashioned but simple form of chemical leavening agent still occasionally used by bakers, and sometimes even in the home, is ammonium carbonate, called "bakers' ammonia." This is a complex salt of ammonium which, under the influence of heat, splits up into ammonia, carbon dioxide and water. The first two are volatile and gaseous at the baking temperature and escape after producing the leavening effect, although a slight odor of ammonia may sometimes be detected in a freshly baked, underdone ginger cake made with this ingredient, for it is more frequently employed in cakes than in bread.

Before the days of stable baking powders, two commonly used chemical salts were employed empirically to produce a leavening effect. The earliest of these was potassium bicarbonate, which evolves carbon dioxide when heated in an oven, but more especially and in greater abundance when treated with an acid. By virtue of this property it was called *sal aeratus,* literally, the aerating or leavening salt, which was later shortened to saleratus. Later, sodium bicarbonate came along as a cheaper substitute for the potassium salt, and the names "potash" and "soda" saleratus appeared as distinguishing terms.

Sour milk, New Orleans molasses, fruit juices, or vinegar, all served as agents for liberating the gas from either of these salts and many cook book recipes still call for these vesiculating agents in cake and pudding baking. Cream of tartar, however, was the favorite activating substance, and so it was perfectly logical and natural that a stabilized mixture of cream of tartar and sodium bicarbonate should first appear upon the market for extemporaneous use in preparing foods which were to be made light. We now call these mixtures "baking powders," but when first introduced they were advertised as "yeast powders"—a highly unethical labeling procedure which in our modern times would bring the seller into conflict with the law.

The subject of baking powders might serve as a starting point for a new and separate lecture, but I shall simply enumerate the types and possibilities. There is always an acidic element present for liberating the gas from the sodium bicarbonate (this form of saleratus being always used for reasons of efficiency and economy), and a diluent which serves also as a stabilizer. The types of baking powders are as follows:

(a) The tartrate powders are mixtures in which tartaric acid or cream of tartar serves as the acidic element.

(b) The phosphate powders in which an acid salt of phosphoric acid (usually sodium or calcium) is employed.

(c) The alum powders, in which a salt of aluminum, belonging generally to the group of alums, is used.

There are variants of these such as baking powders made with calcium acid tartrate or calcium acid lactate, both of which have appeared upon the market.

Distinctive chemical by-products result from the completion of the reaction in each of the classes of baking powders mentioned. In the tartrate powders the principal by-product is a laxative salt known as Rochelle salt in pharmacy and medicine. In the phosphate powders, one of the by-products is sodium phosphate, also used as a saline laxative. In the alum powders, sodium sulphate (also known as Glauber's salt) results from the reaction. Glauber's salt is one of the active agents in Hunyadi and Pluto waters, and is much used in veterinary medicine as a saline laxative.

There are a few other forms of baking powders, unimportant because of their limited use, in which the acidic or even the gas-forming ingredient may differ from those mentioned above, but *in every baking powder* there is a by-product residue of some kind, and it is usually a laxative salt, and for that reason foods made light with baking powder are always open to the objection that they contribute a foreign chemical ingredient to the finished product.

YEAST LEAVENING

When we leaven dough by means of yeast we are employing the oldest of the methods known to man for making bread light and increasing its palatability. There is a lecture scheduled later in this year's series in which yeast will be the subject, so I shall simply mention the fact that yeast is a one-celled plant. Many species are known, but only a few of them are of importance in bread making. The most frequently employed yeast is called by the systematic name of *Saccharomyces cerevisiæ,* literally, "the sugar fungus of beer."

Yeast grows and multiplies, consumes food, and produces excretory products in just the same manner as is done by higher organisms, vegetable or animal. Flour naturally contains constituents which serve as yeast foods, although these are frequently augmented in modern bread making in the interest of improving the product. When yeast is properly fed and has access to certain types of sugars known

as fermentable sugars, it decomposes the sugar according to the following reaction:

$$\underset{\text{fermentable sugar}}{C_6H_{12}O_6} \longrightarrow \underset{\text{alcohol}}{C_2H_5OH} + \underset{\text{carbon dioxide}}{2CO_2}$$

Both the alcohol and carbon dioxide act as leavening or vesiculating agents, and both are driven off by the heat of baking, although in freshly baked bread as high as 0.5 per cent. of alcohol has been reported, which quickly diminishes to zero after the loaf is cut.

The optimum or most favorable temperature for leavening is from 86 degrees to 89 degrees F. Deviations from this small temperature range are likely to produce changes in the quality and flavor of the bread. This explains why real home-made bread is so often variable as to quality, while modern bread, commercially produced on the large scale, is more uniform in quality. In making bread in the home the results are influenced by changes in weather and temperature conditions, while in modern large scale factory control such factors have no effect, as they are excluded by the scientific methods of procedure. There is a distinction, too, in home baking between "yeast" or "barm" and "leaven," which has existed from the earliest times. Yeast or barm is the culture of the yeast cells prepared for inoculating dough in making bread or wort in making beer.

Leaven specifically means a mass of fermenting dough reserved for use in the next baking—"sour dough," it is sometimes called. St. Paul refers to this when he says in Corinthians I:5, 8: "Let us therefore keep the feast—not with the old leaven, neither with the leaven of malice and wickedness," and also in the more frequently quoted reference, "Know ye not that a little leaven leaveneth the whole lump."

SALT RISING BREAD

Another method of leavening bread is by the action of bacteria. This was originally developed as a home process. In this method of bread making wheat flour and corn meal are mixed with hot milk and salt and allowed to stand in a warm place. In the course of a few hours fermentation occurs and the whole mass becomes porous. In this porous condition the mixture is added to dough, as is done in what is known as the slack sponge method of bread making. This dough when set aside in a warm place

undergoes a still further fermentation and when subsequently formed into loaves and baked produces a very fine bread of excellent flavor.

During these leavening changes there are no yeasts present, but a specific strain of bacteria has been identified and pure cultures have been developed for use on the large scale. The chemical changes are different from those observed in any other form of leavening. Carbon dioxide is produced, as is also hydrogen, but alcohol is not present among the by-products.

CHEMICAL CHANGES DURING BAKING

The temperature at which bread is baked ranges from 355 degrees F. to 425 degrees F. The changes produced by the heat are neither numerous nor marked. The major portion of the starch is affected physically by the swelling and rupturing of the individual granules; a small amount of soluble starch is produced, but no significant chemical changes take place except in the crust of the bread, where the starch is largely converted into dextrin, which gives the sweetness and flavor to this portion of the loaf.

Sometimes biological and even chemical changes occur in the finished loaf, due to infections during or after baking. Ropy bread is distinguished by the elastic, stringy condition of the bread crumb when a portion is removed. This is a serious "disease" of bread, and may necessitate some radical changes in the bakery where the infection usually occurs.

Moldy bread is not rare, so far as the common green variety of mold is concerned, but when the red variety, which covers the bread with a blood-red film, is encountered, it usually results in an S O S to the nearest food law enforcement office or chemist, in the belief that some foreign substance has accidentally found its way into the bread or has been maliciously added. Adulterants of bread were formerly common, but are now fortunately rare. Talc, *terra alba,* and clays were mechanical adulterants of the crudest kind and were but rarely reported. Alum was used for centuries, ostensibly for improving the bread, as was also copper sulphate or blue vitriol. Both of these had the effect of apparently improving the quality, texture and appearance of the bread, even when baked from second grade or inferior flours. Alum was used in the proportion of from three to five grains per loaf, and copper sulphate to the extent of one grain per loaf. Both of these adulterants are now universally prohibited by law and have not been reported for many years, although a century ago the practice of such

adulteration must have been quite general, according to the allegations of Frederick C. Accum in his interesting work entitled "Culinary Poisons," published in 1820 and republished in a number of subsequent editions.

Some substances, such as magnesium carbonate, chalk, and lime water, which when used in bread making are of value in overcoming the effects of the use of damaged flour, which they do by neutralizing the acidity present in such flour. Although none of these is harmful, nevertheless they would be classed as adulterants and prosecution would follow their use.

The bleaching of flour brings up still another factor which must be dismissed in a few words. The curious and unaccountable preference of the consuming public for white bread which has accompanied the history of bread making since the times of the ancient Egyptians, has persisted in spite of legislation and education, although at the present time there are those who eat whole wheat and other forms of dark bread for the sake of the added roughage, vitamins, and mineral salts present, and which are stressed by modern advertising so that the purchaser pays a fancy price for what, in any other age and country, would be considered an inferior variety of bread.

Bleached flour is in rather common use. The bleaching is accomplished by the introduction of powerful chemicals (or by the use of the electric spark which generates such chemicals from the atmosphere) in minute amounts during the milling process. In the present state of our legislation they cannot be prohibited because it is impossible to prove scientifically and conclusively that these chemicals are injurious in the amounts which are present. But they are foreign substances and are used only to gratify the unreasonable demand for a pure white flour and pure white bread.

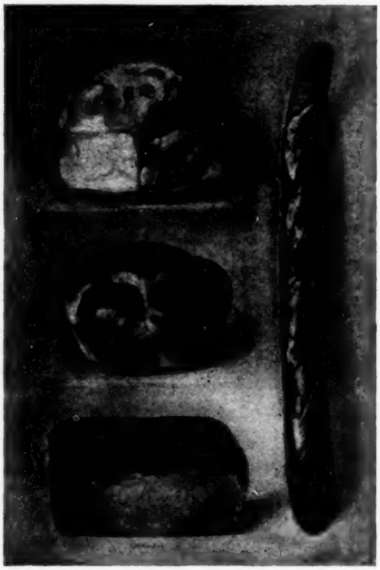
VARIETIES OF BREAD

With the exception of the section devoted to the specific regulations regarding bread in early English law, we have been discussing simply "bread"—particularly wheat bread. When we come to the question of varieties and definitions, we enter upon an entirely new phase of the subject, especially when they are of sufficient importance to warrant legal definitions. Here we meet wheat bread, rye bread, barley bread, whole wheat bread, Graham bread, milk bread, brown bread, gluten bread, raisin bread, corn bread, and potato bread—to mention the more important varieties in which the name is indicative of composition.

Others of less importance are gingerbread (which is really a variety of cake), nut bread, oatmeal bread, nut and raisin bread, bran bread, chestnut bread, rice bread, lotus root bread, malt bread, acorn bread, and sweet potato bread.

Inasmuch as legal standards and definitions are in a formative stage at present as regards some of these it must suffice to say that a bread for which any particular composition is claimed must be true to name.

Then we have names which are indicative of styles or types of bread, irrespective of composition. Among these are French bread, Vienna bread, pan bread, health bread, pulled bread, etc. Finally there are smaller units and variant forms such as biscuits, rolls, buns, rusks, muffins, waffles, pancakes, corn dodgers, buckwheat cakes, flannel cakes, Johnny cakes, fritters, pretzels, scones, bannocks, Sally lunns, hot cross buns, poppy seed rolls, etc. Zwieback and toast are forms of bread modified by heating, practically consisting of converting crumb into crust.



Domestic, Cottage, Graham and French Breads.

HOT CROSS BUNS

We might take any of these and follow an interesting bypath. Let us try hot cross buns. But of course you say hot cross buns, so popular during Lent, are associated with and have developed from the Christian religion. Well, the custom of serving small loaves imprinted with a simple symbol in connection with a religious observance was first practiced by the Egyptians, who dedicated theirs to the moon goddess; by the Greeks, whose "bons," from which we derive the word "bun" from the accusative form "boun," was a sacred cake offered to Astarte. Sometimes a cross was marked on these Greek buns. In the ruins of Herculaneum small loaves were found which were plainly marked with a cross. A "cross marked bread" was eaten by the Saxons in honor of their goddess Eoster, whose name is perpetuated in the Christian festival of Easter. In some parts of England the housewife "crossmarks" her loaves to insure successful baking. To indicate how religious observances may degenerate into superstitious practices, it is said that in Dorsetshire a hot cross bun, baked on a Good Friday, is hung up over the chimneypiece to insure good bread during the ensuing year.

We must not overlook the miracles which are related in connection with bread. The one concerning the loaves and fishes told in the gospel according to St. Matthew has been duplicated in a series of miracles described in ecclesiastical history coming down to a date as late as the seventeenth century, according to Brewer's Dictionary of Miracles.

Another bread miracle, this time from the Old Testament records, is described in I Kings 4:42, where two loaves of barley bread sufficed to feed one hundred men.

THE BREAD AND CHEESE ORDEAL

This interesting method of crime detection was first practiced in Alexandria in the second century by the Christian church, and in England it was revived a thousand years later. A *corsnaed* or "trial slice" of consecrated bread and cheese was administered by the priest from the altar to one accused of a crime, with the accompanying curse that if the accused were guilty, God would send the angel Gabriel to stop his throat that he might not be able to swallow. In India they have a corresponding "trial by rice." The odds in this game would seem to be against the defendant, for even in the cracker-eating races where no psychological factor is involved it is difficult to swallow unmoistened food.

BREAD FROM HUMAN BONES

One of the shocking and revolting occurrences in the history of bread was the use of meal made from ground human bones for making loaves as a substitute for bread made from flour. This occurred in 1594, when Henry IV was besieging Paris and the famished inhabitants lacked food. The Guise party, who were defending the city, robbed the charnel house and sepulchres of the Church of the Holy Innocents, and having ground the bones, mixed the meal with cereals and baked it into small loaves which were called Madame de Montpensier's cakes.

BREAD FRUIT A MARQUESAN STAPLE

Breadfruit, also called *mei,* is a large pulpy fruit of the South Sea Islands, where it has constituted the principal article of nourishment for centuries—hence the name. It cannot be used for making bread of any kind. Boiled or baked soon after it ripens it has a pleasant flavor like a well-cooked, mealy potato. As crops come at intervals of not less than eight months, very little of it is consumed in the freshly ripened state. It is usually buried in pits, covered with earth and

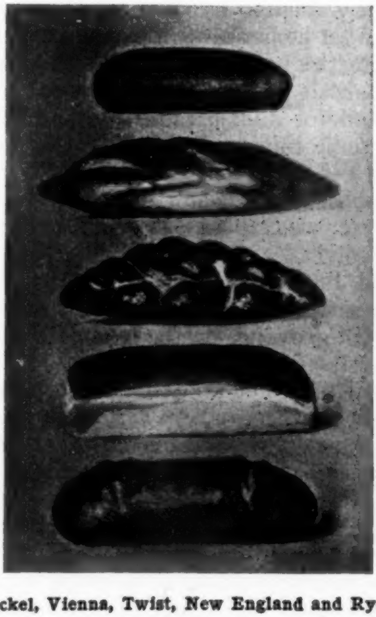
The Bread Fruit Tree.

allowed to rot. Sometimes these pits are kept closed for five years. In the Marquesan Islands they are opened only by permission of the king. It has been known to be kept buried for ten years. It undergoes a series of fermentation changes, the interior remaining light in color. The odor and taste are pungent and acrid. The principal dish made of it is called *poi poi,* not to be confused with the *poi* of Hawaii. *Poi poi* and raw fish constitute the major diet of many Pacific islanders.

SCHOOLS FOR BAKERS IN 18th CENTURY FRANCE

During the latter part of the eighteenth century a college or training school for bakers was instituted in Paris by Parmentier, a famous French pharmacist, who will also be remembered as having introduced the cultivation of the potato into France. Even now the French baker's apprentice has to go through a four-year course of studies to qualify for a master's position.

Parisian bread, usually called French bread, is in long, thin loaves which are practically all crust. The art of making this kind of bread was acquired from the Austrians during the time of Napoleon. A jury of French, English, and Italian epicures once made a study of all



Pumpernickel, Vienna, Twist, New England and Rye Breads.

European breads and pastry and awarded the prize to the Swiss for pastry and to the Viennese bakers for bread.

Hungarian flour is said to be the best in the world, and Hungarian peasant loaves are probably the largest known, weighing over twelve pounds each.

In Germany the use of white bread has always been considered a mark of prosperity. The poorer classes eat *schwarzbrod,* made of rye flour, and *pumpernickel,* made of unbolted rye meal. Epicures nowadays delight in eating both of these latter varieties, especially with cheese.

BREAD STANDARDS

So far as legal standards for certain types of bread are concerned, these are of both State and Federal origin and enforcement. The best summary of the situation in this respect is herewith quoted from the official bulletin of the New Hampshire Board of Health and was written by Dr. Charles D. Howard.

"New Standards for Bread

"Definitions and standards for certain types of breads, as recently adopted under the Federal Food and Drugs Act and now in force in New Hampshire, are calculated henceforth to give the consumer what he has always fondly supposed he was getting but which in practice he has hitherto never virtually received.

"The standards to be discussed relate to those for whole wheat bread and for milk bread. A standard for the latter we have had for some time, milk bread having been defined as the product which differed from white bread ('bread') in that not less than one-third of the water ingredient employed in the formula for the latter was replaced by whole milk or by its equivalent in whole milk solids.

"It should be noted that this definition stipulates 'whole milk.' For some years there has been an extensive practice, and one which is still growing, on the part of the bakers of incorporating more or less skimmed milk in their loaves. And this is well. Skimmed milk not only contains valuable food elements but its use as a bread ingredient results in a loaf which is more nutritious, more palatable, and of better texture. Skimmed milk is cheap and its utilization in this way represents a helpful outlet for a farm product. Some bakers, however, have made the mistake of applying the name 'milk bread' to a loaf so made, this constituting a misbranding, inasmuch as skimmed milk is not 'milk.' Because of the natural reluctance to make use of such a term as 'skimmed milk bread,' the name 'dairy bread' for a loaf so pre-

pared has been proposed, but thus far this name does not seem to have met with any appreciable acceptance on the part of the industry.

"The new definition for milk bread, however, recognizes no half way (or 'one-third' way) measures. Contending that milk bread should be just what the name implies, the Committee on Definitions and Standards for Foods has now set up the definition which requires that in the loaf so-called, *all* of the 'water ingredient' as for white bread shall have been replaced by whole milk or by its equivalent in whole milk solids, and this definition has been duly promulgated by the Secretary of Agriculture. In its practical working out this will doubtless mean that but little true milk bread will be made. The alternative to the latter is to label the product 'bread' and to declare upon the wrapper the proportion of milk included.

"For the type hitherto variously sold as 'whole wheat bread,' 'entire wheat bread' and 'graham bread,' no standard of composition has existed up to now. This has meant that the consumer buying a loaf under any one of these names has been given a dark bread of exceedingly varied composition. Almost always it has contained at least some white, or 'patent' flour. Sometimes as much as seventy-five per cent., or even more, of the flour ingredient consisted of the latter. Commonly it was a fifty-fifty proposition of 'patent' or 'clear' with 'nearly' whole wheat flour. Such a mixture gives a loaf of fair volume, to many consumers it proves very palatable, and these have eaten it fondly supposing they were consuming 'whole wheat bread' or 'graham bread.' There was however extensively sold another variety under this name, made from what is known in the industry as 'shovel graham,' which, interpreted, means a patent or clear flour blended with 'middlings,' i. e., with the finer ground and mill-sifted branny portions of the wheat berry as once commonly sold for cattle feed. Another cheap variety of flour, known to the trade as 'red dog,' was also utilized to some extent in this connection. Finally, limited quantities of bread have been baked from a flour which would be entitled to the name 'whole wheat' were it not for the bolting out of a portion of the bran.

"All this confusion and substitution is now due to be avoided —as soon as the bakers can become familiar with the new requirement. To these we would point out that to label as 'whole wheat' or 'graham' (these terms, be it understood, are synonymous) a loaf made in any part from white flour, or from a flour which does not contain all of the wheat berry with no removals other than what may result from the cleansing and scouring, is to be deemed a violation.

"To comply, the bakers should now have no difficulty. Such a bread, of course, goes back to the flour, and all of the millers

now understand that the flour labeled 'whole wheat' or 'graham,' must be just that. Genuine whole wheat bread has been made in very limited quantities for many years. Such a loaf is small in volume, coarse in texture, and to many consumers is not very palatable. While its use has been extensively urged by certain food faddists, as well as by many dietitians who have not been fully informed as to the scientific facts involved, today we know that competent authorities are inclined to look askance upon its daily use in the normal diet. This method of insuring bowel action can be regarded as being but a phase of the laxative-taking habit, and it is now recognized that the mechanical irritation thus induced is objectionable and may have ultimate serious consequences. On the other hand, authorities in nutrition now concede that ordinary white bread—the type by far the most palatable to the average consumer for steady consumption—is in every wise a suitable and sustaining article of food when consumed in the usual way as a part of a mixed diet.

"As with the new milk bread requirement, it is probable that but little genuine whole wheat bread will be made, comparatively speaking. Instead, bakers have found that their trade in this connection is best satisfied by an approximately fifty-fifty loaf, and this, presumably, is what they will continue to bake, for the most part—but under a different label, henceforth. Thus one will be in position to get just what he wants, and to know just what he is getting.

"The action of the Standards Committee at this time in rescinding the 'one-third' standard for rye bread, as formerly in force, and setting up no other in its place, is of interest in this connection. The Committee was influenced by a number of considerations in taking this action, but one of which need be referred to here. As compared to the other breads mentioned we have a somewhat different situation in this case in that there is general consumer understanding in this country that in a bread so called the rye serves merely as a flavoring. Because of the lack of gluten in rye flour, an all rye loaf would be highly lacking in volume, very strong-flavored, quite unattractive in appearance, and, by most native Americans, at least, would be deemed as scarcely edible. Testimony given before the Committee by the baking industry was to the effect that in this country the bread sold under this name may contain from as little as five per cent. of rye flour (in this case to be deemed as mislabeled) up to the high percentages which characterize the little made product known as 'pumpernickle.' In this locality consumers seems best to be suited by the form known as 'Swedish rye,' a syrup-sweetened bread made from a 'clear' wheat flour with about 20 per cent. of rye, the latter serving to import a reasonably distinct rye flavor.

"Recently a health officer sent this department a specimen of rye bread with the request that it be analyzed to determine its suitability for diabetic use. It may be worthwhile pointing out here that for this purpose neither rye nor whole wheat bread is essentially better suited than is the common white variety, the essential here being a bread baked from a flour or meal from which the starch, or most of it, has been removed. Rye flour contains about the same proportion of starch as does wheat flour."

WHOLE WHEAT BREAD

Some years ago there was an agitation in England to compel the use of whole wheat bread in place of white bread. An official statement signed by eight of the leading medical men of Great Britain contained the following emphatic paragraph:

"In view of the inferior nourishing qualities of the white bread commonly sold in this country, we urge that legislation should be passed making it compulsory that all bread sold as such should, unless it is distinctly labeled otherwise, be made from unadulterated wheat flour containing at least 80 per cent. of the whole wheat, including the germ and semolina."

VITAMINS IN BREAD

A short time later another and more emphatic recommendation to the same effect appeared, this time signed by twenty-six of the leaders in British medical practice. This agitation occurred before our present advanced knowledge of vitamins had developed. Now that we know the facts regarding the vitamin content of different kinds of bread we find that whole wheat bread is superior to white bread, although neither constitutes a perfect life-saving ration. White bread contains negligible amounts of growth-promoting "A" and the anti-neuritic "B," and none whatever of the anti-scorbutic "C" and the anti-rhachitic "D." Whole wheat bread contains A and B in larger amounts, but C and D are both absent. When butter is eaten with bread the amount of A is increased, and when milk is used with it the amounts of A and B are raised and C is also contributed. When wheat germ is present the sterility-preventing E enters the scene, but the anti-rachitic D does not enter into bread unless it is added through the medium of one of the concentrates that are now available.

Vitamin reinforced bread is already making its appearance on the market and it is probable that any progress in bread making in the future will be made along the line of developing a loaf of bread that will contain all of the elements necessary for the sustaining of life.

HOME-MADE BREAD

Bread making on the large scale as now conducted in civilized countries is a scientifically controlled process in which a deviation from the laws of cleanliness and sanitation brings its own punishment in the lowering of the quality and uniformity of the product and a consequent loss of business. We smile at the recipes of ancient days for making bread in the home which start out with a quantity of flour that appalls us.

"Put a bushel of good flour in one end of your trough"; thus begins the recipe in *The Housekeepers' Instructor* published in 1805 in London, while Mrs. A. Glasse, who wrote "The Art of Cookery Made Plain and Easy" in 1788, also says. "Take a bushel of the finest flour."

It makes us wonder just where we can draw the line at calling a product "home-made bread." There is one thing certain, real home-made bread or any other home-made product, cannot be made on a commercial scale, as is sometimes advertised with a manifest disregard for the intelligence of the purchasing public. But there is a lot of real home-made bread in parts of the world where modern scientific and commercial methods have not yet penetrated. Let us ramble in some of these panary byways before bringing this lecture to a close.

In Iceland, codfish, dried hard and beaten to a fine meal, is mixed with flour to make a nourishing variety of bread. In Norway the housewife may make either "lepse" or "fladbrod." The former is an unleavened bread, sweetened and flavored with aniseed. It is baked on an iron plate over an open fire in thin crisp sheets. The "fladbrod" is made from a dough of coarse barley meal and water. It is also unleavened and is baked in thin sheets, often on a large, flat, heated stone. A winter's supply is sometimes baked in autumn and put away in storage until used.

The bread of Sweden called "knackebrod" is an unleavened bread made principally of rye meal and its characteristic texture is due to the presence of a peculiar form of sour milk. It is baked in thin round discs with a hole in the center. They are strung on long poles and stored on racks near the ceiling. Each baking usually lasts a family for three months.

Hungarian loaves are made from rye flour and are leavened. They are gargantuan in size, weighing more than ten pounds each, as a rule. A Hungarian laborer, who eats very little else, will consume three such loaves a week.

The highly-glazed, lye-dipped, salt-sprinkled pretzel hails from Germany. Its twisted form is said to be an attempt to fashion the letter B, the initial letter of the German word "brezel," which denotes this knot-shaped, thirst-provoking form of "cracknel," the generic term for any hard, brittle biscuit or cracker. And here we are reminded that the American who travels in England soon learns that what we call crackers are called biscuits by the English, who serve them freely and in multitudinous varieties with the inevitable afternoon tea.

Anatolian villages have community bakeries. The loaves are small, unleavened, and so hard that strangers have difficulty in eating them.

Sardinian housewives bake bread once a week in thin, brittle sheets called "cartá de musica."

In Arabia a small pit is dug in the ground, a fire is built in it, and after the pit is heated, the embers are raked out and pancake-like sheets of unleavened dough are plastered around the heated sides of the pit. When the baking is completed the flat crisp sheets are picked off the sides with a pair of tongs.

The dough is made in the home in Persia and taken to the public ovens for baking. Here are huge mounds of hot stones, rounded like large pebbles. The unleavened dough, almost like a batter, is poured over these hot stones and is subsequently removed in irregular brittle sheets often a yard in diameter.

Chinese bread is also unleavened, and in thin sheets like those of other countries that we have mentioned. This form can be baked quickly with a minimum amount of fuel. Poppy seeds and sesame seeds are frequently used to decorate and flavor Chinese bread.

In Korea the dough is placed on a board out in the open or in the doorway of the home or the bakery, and pounded with mallets in lieu of kneading. As Korea is a country where insects and flies abound, and as the bakers are too busy pounding with their mallets to bother about removing foreign substances, you can imagine the result. The Koreans have a proverb: "He who would enjoy his food should not look over the garden wall." Need more be said about community sanitation and ideas of cleanliness?

In most Central and South American countries the home baking is done out of doors. The native woman grinds the corn on a concave stone called the "metate," with a grinding device that looks like a rolling pin. The large, flat sheets of bread which are never baked sufficiently to brown them are called "tortillas." As they are usually

underdone, Americans prefer the *"toto posti"* or crisp variety. These primitive flapjacks support thousands of our Pan-American brethren and furnish the calorific energy for the innumerable revolutions which seem to occupy the leisure of O'Henry's one-time friends and companions.

In Ecuador bread dough is made up into various animal forms in celebration of their many feast days. Which reminds one of Eugene Field's gingerbread dog-and-cat fight and the fact that in sixteenth century Paris pharmacists were given a monopoly of the sale of gingerbread—then a new and wonderful discovery.

In the Southwestern United States the Zuni Indians use the "metate" in preparing meal for the thin sheets of unleavened cornbread known as *kiki,* which are baked on hot stone slabs. In Southern California certain Indian tribes still subsist upon acorns as their principal food. These are used in the roasted and also in the dried condition and sometimes are buried in boggy ground where they undergo a kind of fermentation during which they turn black, but are not decomposed to any pronounced extent. Sometimes in order to remove the bitter principle, the acorn, after being ground to a meal in a crude mortar-and-pestle grinding device, are leached with warm water. Finally, the acorn meal, roasted, dried or leached and dried, is mixed with water, and without leaven or seasoning is made into loaves about two inches thick wrapped in leaves and baked on hot stones. Sometimes the leaves are first wrapped in moist clay which seems to absorb the bitter substances. The resulting bread is black in color and has the consistency of soft cheese. The flavor is sweet and the bread undoubtedly possesses nutritive qualities.

Acorns have been used as food by the peasants of England, France and Italy. They are said to still contribute about 20 per cent. of the total food requirements of the Spanish peasants.

There is one section of the world where bread is a rarity. It is the region of the Siberian tundra, where bread is brought in as a luxury by wealthy traders who distribute it as we sometimes distribute confectionery.

In these many lands of the several continents we may have been impressed with the numerous varieties of bread which are indigenous to the countries mentioned, but we who are particular and discerning have not been notably impressed by the edibility of the products, specially from the standpoint of cleanliness and sanitation.

Would it surprise you to learn that the United States Capitol building in Washington once housed a bakery? In the early days of the Civil War, when the Confederates were approaching Washington, and while the dome was being built overhead, the basement of the building was turned into a storage house for meal and flour, and a military bakery was set up from which the community needs were supplied. This was due to a rumor that all the flour mills in the adjacent country were to be burned. This community bakery changed the baking habits of the city so that commercial bread rather than home-made bread was the predominant form of the staff of life.

Here we are at the end of a trail which started several thousand years before the beginning of the Christian Era, and has brought us up to the present time, in spite of many deviations and circumlocutions. And where do we go from here? Time alone will tell. If our present civilization continues, the bread of the future will be better than the average bread of the civilized peoples of the present, because it will have been scientifically developed to the point of highest efficiency. If we recede, as some feel that we may, we still have little to lose, for the breads of primitive peoples, with all of its sanitary handicaps, are more nourishing than the many of the ultra-refined, extra-palatable, white flour breads in common use today.

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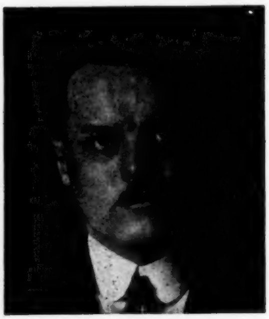
PHOTONS AND ELECTRONS*

By George Rosengarten, Ph. D.

Assistant Professor of Physics, Philadelphia College of Pharmacy and Science

THE PHOTO CELL, almost unheard of a few years ago has a thousand uses. It makes the Talkies talk, and will soon reproduce for us in Television the faces of those we hear over the air, right in our homes. It can send an alarm of fire, detect the criminal at his work, start machinery and turn on the electric lights as daylight fades. All this and much more may be accomplished without the hand of man.



George Rosengarten. Ph. D.

To understand the mysteries of this glass tube we must have a picture of the physical world as it is painted by the physicist after long years of research in his laboratory.

The nature of light and the nature of matter must be understood. Light sometimes acts as waves and sometimes as particles. Perhaps it is both. The energy of the light wave appears to be concentrated in minute bundles called photons. Red photons and yellow protons, visible and invisible protons, each kind with a different amount of energy. X-ray photons have more energy than red or yellow photons, therefore penetrate the surface of bodies, and in fact very often pass right through some of them.

The atom is no longer the smallest particle of matter. It in turn has been found to consist of smaller bodies; protons and electrons, positive and negative charges of electricity. Some of these electrons can be knocked from the parent atom if the bombardment has sufficient energy.

The photon sometimes possesses enough energy to accomplish this, and when it strikes an atom the electron is sent off with high velocity carrying a negative charge of electricity. This is what happens in the photo-electric cell.

*One of a Series of Popular Science Lectures given at the Philadelphia College of Pharmacy and Science, 1932 Season.

What Is the Twentieth Century Picture of the Physical World?

A large body of gaseous matter 93,000,000 miles away from the earth at a temperature of some million degrees. This is the sun, just one star in 3000 million of stars in our galaxy. The mass of the sun is $2x10^{27}$ tons (2 followed by 27 zeros) and radiating into space at the rate of $12x10^{13}$ tons per year. We owe our existence on earth to this radiation. Space is dark and cold and only when this radiation falls upon matter do we have light.

That light travels in straight lines, is reflected and refracted, are phenomena familiar to nearly every one. Perhaps such phenomena as interference, as polarization and the photo-electric effect are not so familiar and, indeed, have caused the best minds much concern in an endeavor to offer an explanation.

What is light? What is matter? Can there be any relation between these phenomena?

Most of us are familiar with such properties of matter as size, mass, density, hardness and the phenomena of elasticity and gravitation which play such important parts in our every-day life. We have passed through many stages in our attempt to determine the nature of matter. Molecules, atoms, electrons and protons, each in turn have been considered the smallest particles of matter.

Light falling upon matter under suitable conditions seems to tear the electron from the parent atom, sending it off to speak to us in the talking pictures, to transmit the smiles of a friend by Television or to sound the burglar alarm as an enemy steals past the electric eye of the photo cell.

The closer one examines into the nature of things the less he appears to know, so it is with some hesitation that I attempt to direct your thoughts toward the answer to these questions.

WHAT IS LIGHT? The sources from which light appears to emanate are the sun, stars, and bodies upon the earth usually heated to incandescence. Until the beginning of the nineteenth century invisible radiation had not been discovered. It is not necessary that the body be heated to incandescence. From a hot metal ball radiation proceeds and may be detected by the radiometer. This instrument consists of a delicately balanced wheel carrying four vanes, one side of each being blackened, while the opposite side is a reflecting surface. When the invisible radiation from the metal ball falls upon the

blackened surface of the vanes it is absorbed and converted into heat energy sufficient to cause the molecules of the residual gas within the bulb to react against the vane causing the wheel to rotate. The visible light from an electric lamp causes the wheel to increase in speed. That something proceeds from the light source forms the basis of all our modern theories of light. When the light leaves the source it appears to travel with a velocity of 186,000 miles per second in a straight line unless it should pass from one medium to another or pass very close to a large body of matter when according to Einstein it is bent from the straight line path. Photographs of stars appearing close to the sun at the time of a total solar eclipse when compared with photographs of the same stars when the sun is not near the path of the light ray show such bending. Light is affected by the gravitational attraction of large masses.

That space is dark can be observed any night, and only when this radiation from the sun falls upon the moon and the planets is it reflected to the eye as visible light. At the time of a total eclipse of the sun the light rays are gradually shut out by the moon as it passes in front of the sun and the earth becomes darker and darker. At the moment of totality the corona appears against the dark background of the sky.* The stars appear and the planet, Mercury, usually too close to the sun to be seen without an eclipse, can be clearly observed. The heated gases from the surface of the sun are projected millions of miles into space, soon becoming invisible.

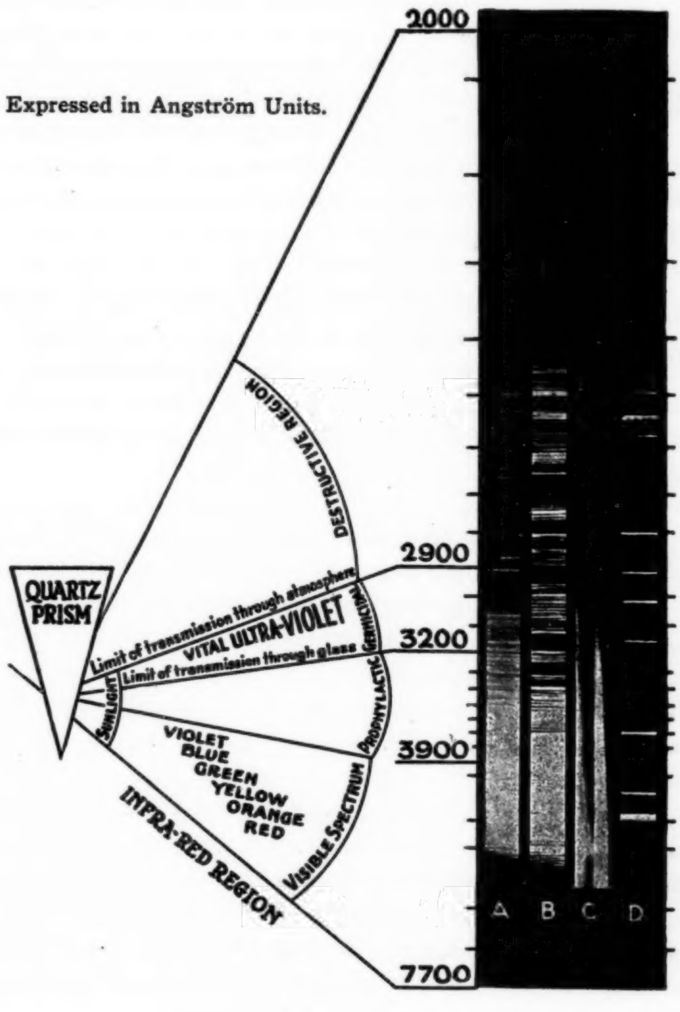
The occurrence of another total eclipse of the sun on the 31st of August, 1932, and visible in the southern part of Maine, the northern part of New Hampshire and Vermont, and parts of Eastern Canada during the vacation season offers an extraordinary opportunity to view one of natures most inspiring phenomena.

What happens when light comes in contact with a different medium? Part of the energy in the light ray will be reflected and part will be refracted. That portion that suffers reflection behaves like the elastic billard ball when it bounces from the side cushion. The angle of incidence equals the angle of reflection. The portion of the light ray which enters the second medium suffers a change in direction. If the light passes from air to a denser medium like water the light ray will be bent toward the normal to the surface. The opposite bending takes place when the light passes from a dense to a less dense medium.

*See Popular Science Lectures (Vol. VI), "What and Where Are the Stars."

REFRACTION OF LIGHT

When white light passes through a triangular prism of glass refraction occurs. The light ray is not only bent from the straight line, but is split up into the so-called spectral colors. The amount of refraction varies with the different colors being greatest in the case of the violet ray, and least in the case of the red ray.



INTERFERENCE OF LIGHT

Two monochromatic light rays from the same source appear to interfere with each other at certain places and to reinforce each other at other places. When the yellow light from the flame colored by sodium falls upon a pair of glass plates tightly clamped at one side, dark bands appear upon the glass plate, marking regions of interference. What can be the nature of the light ray that it can produce both darkness and light?

POLARIZATION OF LIGHT

Perhaps a still more mysterious phenomenon takes place when the light ray passes through a crystal of Iceland Spar. In this case the light ray divides itself into two rays, producing a double image. The light after passing through the crystal possesses different properties in the two rays. The light is said to be polarized.

PHOTO-ELECTRIC EFFECT OF LIGHT

The phenomena of photo-electricity in which the light ray falling upon a charged plate of metal causes it to lose its charge added another difficulty in explaining the nature of light, electricity and matter. It is this phenomena of photo-electricity that I would have you consider with me in this lecture.

NATURE OF LIGHT

In an attempt to explain the nature of light, Sir Isaac Newton proposed a corpuscular theory. A luminous body was one which was continually sending out multitudes of small and swiftly moving corpuscles which fell upon the eye producing the sense of sight. At other times he resorted to the hypothetical ether to explain some of the phenomena he observed. Until the year 1800 most of the scientific world was in favor of the corpuscular theory.

About this time Thomas Young brought forth a beautiful explanation of the nature of light based upon a wave motion in an elastic medium the ether, which filled all space but did not retard the earth and other bodies moving through it. Light was considered to be a transverse vibration in the elastic ether and capable of being propagated at the velocity of 186,000 miles per second. The ether was a convenient invention, but has never been observed.

In passing I shall pause just a moment to do honor to an American Scientist whom the world will never forget—Albert A. Michelson. For fifty years he worked intermittently upon the problem of the velocity of light. This is one of the most important constants of nature. At one time Prof. Michelson was measuring the speed of light as it flashed across the mountain tops in California, and more recently was sending the light back and forth through a large pipe line about a mile long, from which the air had been removed. It was during the progress of these later experiments at the age of 79 that he died on May 9, 1931. Michelson's most recent value for the velocity of light is 2.99796×10^{10} cm. per second.

It was Maxwell who demonstrated that the vibration was of an electro-magnetic character. That this wave theory explained beautifully the phenomena of light known at that time cannot be controverted. The light ray may be considered to have the properties of a wave. Some property of the light, be it electrical or mechanical, varies with high frequency between two extreme limits and may be represented diagrammatically as a wave. The distance between similar points in the light wave is called the wave length and the number of such waves taking place in a second is known as the frequency of the light. The terms wave length and frequency have become household words since the introduction of the radio. The vibrations are considered to be transverse, but taking place in all possible planes at right angles to the direction of propagation of the light ray. The phenomena of polarization is produced when the light passes through a crystal in which all but one of the directions of vibration are removed. The ray is said to be plane polarized. The phenomena of interference is explained by the wave theory; in fact, it is one of the reasons for the wave theory. When two monochromatic light rays meet in space and have the opposite phase characteristics they will interfere with each other, but if they meet in the same phase they will reinforce each other. A rather beautiful explanation.

With the discovery of photo-electricity in 1887 by Hertz, a necessary revision of the theory of light became necessary. Light falling upon a clean metal surface causes it to lose its charge. Before considering in detail this phenomena, let us gather a few more facts.

It is one of the achievements of modern physics that we have been able to correlate so many of the physical phenomena widely different in character. The wave theory of light has enabled us to correlate such phenomena as the X-rays and radio as different aspects of radiant energy and to determine the wave length and the frequency of vibration.

LIGHT, VISIBLE AND INVISIBLE

The Spectrum of Radiant Energy (Fig. 1) affords at a glance what has been accomplished by scientific research. Before the year 1800 only the visible region was known. What a small portion of the entire range of possible frequencies it includes. Into the invisible region, where frequencies higher and lower than those of the visible exist, science has penetrated. Cosmic rays from outer space, Gamma radiations from radioactive substances, the X-rays and the ultra violet rays all have frequencies higher than the visible light. The relation between the wave length and the frequency may be represented by the formula

$$\text{Wave length} = \frac{\text{velocity of light}}{\text{frequency of vibration}}$$

Since the velocity of light is 3×10^{10} centimeters per second the wave length of red light which has a frequency of 10^{14} turns out to be $\frac{1}{10000}$ centimeter.

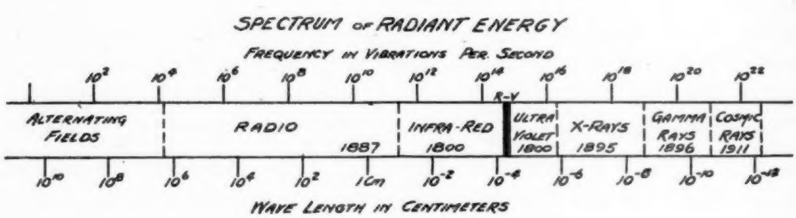


Fig. 1.

The infra-red and the radio waves have lower frequencies and corresponding longer wave lengths than the visible light. It was the infra-red radiation from the metal ball that caused the radiometer to spin and the radio waves are at present passing through this room, even though we are unable to detect them without special apparatus. The eye as a detector of light is sensitive to only a very limited region.

The ultra violet light is absorbed by the cornea or outer covering of the eye. The X-rays and the Gamma rays from radium are very penetrating and produce severe burns to the skin if exposed to the radiation for any length of time. The wave theory of light has been of remarkable assistance in bringing together all these phenomena, but falls down completely in explaining the phenomena of photo-electricity, the action of light upon matter.

WHAT IS MATTER? For centuries man has sought an answer and slowly the nature of matter has been unfolded. Anaxagoras 500 B. C. taught that matter consisted of combinations of small invisible particles and his successor Democritus about 400 B. C. believed the universe to consist of empty space containing an almost infinite number of indivisible and invisible particles differing only in form and arrangement.

An almost unbelievable mass of information has been accumulated since that time relative to the question we have asked. Heat is the energy of the molecular motion. These minute particles of matter by their interaction, being in continuous motion, except at the temperature of absolute zero when all molecular motion has ceased.

Electricity was discovered and its close association with matter soon became apparent. If a piece of copper and a piece of zinc be placed in a dilute solution of hydrochloric acid and then connected ex-

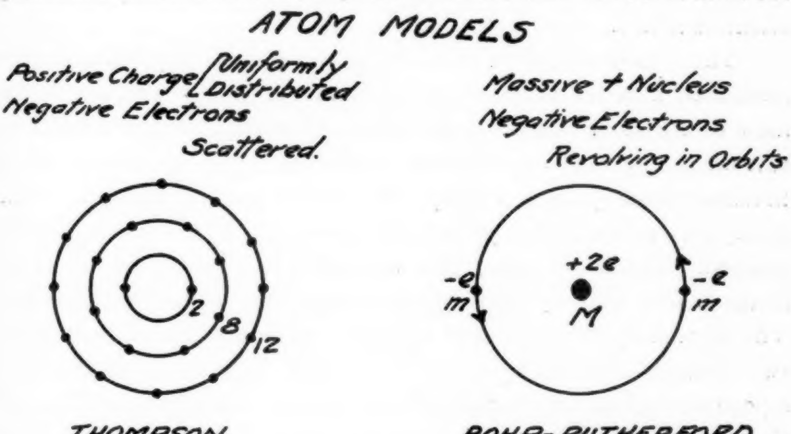


Fig. 2.

ternally to a galvanometer a flow of electricity is observed. The hydrochloric acid in dilute solution with the water appears to have separated into so-called ions of hydrogen, carrying a positive charge and ions of chlorine carrying a negative charge. When the piece of copper and zinc are placed in the solution no effect is observed until they are connected by a conducting wire. Immediately the solution becomes active and a current of electricity flows. The positive H and the negative Cl ions migrate to the metal plates and carry electricity through the solution.

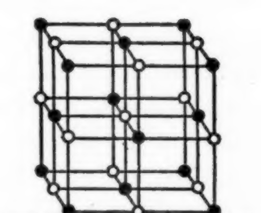
For a time the atom was considered to be the smallest indivisible particle of matter, but with the advance of science we have been able to penetrate the atom. For the past 30 years the atom model builders have been at work trying to develop a model of the atom (Fig. 2) that would possess all the peculiar properties which were discovered to be associated with matter. The Thompson atom, proposed by J. J. Thompson, was considered as a sphere of positive electricity of uniform density, throughout which the electrons were distributed in various shells. This atom model failed in many respects and was soon superseded by the Bohr-Rutherford atom model. We must remember that these are only models and the actual atom would, no doubt, not recognize itself. The dimensions of the atom are so small, of the order of one hundred millionth of a centimeter that it is impossible to see them and to construct a model of one is an interesting pastime for scientific minds.

The Bohr-Rutherford atom model considered the positive charge associated with the nucleus and to form the greater portion of the mass of the atom. Most of the atom was empty. The nucleus was surrounded by electrons rotating in various orbits something like a miniature solar system. Perhaps this was the germ of the idea. That it explains many of the phenomena associated with matter must be granted. The X-rays may pass through the empty space of many atoms before striking the massive nucleus and suffering deflection. The atom of hydrogen, atomic number 1, is the lightest of the ninety-two elements indicated by the periodic table. It is considered to have a positive nucleus with a charge 1 and to have one negatively charged electron revolving around it. Helium with atomic number 2 has a nucleus containing four positively charged protons and two negatively

Periodic Table showing Atomic Numbers and Valences									
Period	Group 0	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
0		1 H (1) 1.008							
I	2 He (0) 4.00	3 Li (1) 6.940	4 Be (2) 9.02	5 B (3) 10.82	6 C (4) 12.000	7 N (5) 14.008	8 O (6) 16.000	9 F (7) 19.00	
II	10 Ne (0) 20.2	11 Na (1) 22.997	12 Mg (2) 24.32	13 Al (3) 26.97	14 Si (4) 28.06	15 P (5) 31.027	16 S (6) 32.064	17 Cl (7) 35.457	
III	18 A (0) 39.91	19 K (1) 39.096	20 Ca (2) 40.07	21 *Sc* 45.10	22 *Ti* 48.1	23 *V* 50.96	24 *Cr* 52.01	25 *Mn* 54.93	26 *Fe* 27 *Co* 28 *Ni* 55.84 58.94 58.69
		29 *Cu* 63.57	30 *Zn* 65.38	31 *Ga* 69.72	32 *Ge* 72.60	33 As (5) 74.96	34 Se (6) 79.2	35 Br (7) 79.916	
IV	36 Kr (0) 82.9	37 Rb (1) 85.44	38 Sr (2) 87.63	39 *Y* 88.9	40 *Zr* 91.	41 *Cb* 93.1	42 *Mo* 96.0	43 *Ma* ?	44 *Ru* 45 *Rh* 46 *Pd* 101.7 102.91 106.7
		47 *Ag* 107.880	48 *Cd* 112.41	49 *In* 114.8	50 *Sn* 118.70	51 Sb (5) 121.77	52 Te (6) 127.5	53 I (7) 126.932	
V	54 Xe (0) 130.2	55 Cs (1) 132.81	56 Ba (2) 137.37	57-71 Rare-Earths	72 *Hf* 180.8	73 *Ta* 181.5	74 *W* 184.0	75 *Re* ?	76 *Os* 77 *Ir* 78 *Pt* 190.8 193.1 195.23
		79 *Au* 197.2	80 *Hg* 200.61	81 *Tl** 204.39	82 *Pb** 207.20	83 Bi* 209.00	84 Po* 210.0	85——	
VI	86 Rn (0) 222.	87——	88 Ra* (2) 225.95	89 Ac* 227	90 Th* 232.15	91 Pa* 230?	92 U* 238.17		

charged electrons giving a net charge + 2e. Two electrons each with a charge — e revolve about the nucleus. Each element is produced by the addition of positive and negative charges to the parent atom, hydrogen.

The elements of Group 0 are the inert gases and appear to be very stable. The atom with atomic number 11 is sodium and falls in Group 1 of the periodic table. It is interesting to note that the photoelectric phenomena is very characteristic of the elements in Group 1. These elements, the alkali metals, are supposed to have one more electron than the inert gases.



O *Sodium Atom* ● *Chlorine Atom*

Fig. 3.

These atoms unite in some peculiar way and in many cases crystallize in most beautiful forms. By sending a beam of X-rays through such a crystal and studying the pattern produced upon the photo-

graphic plate we have learned much concerning the arrangement of the atoms in a crystal. The model shown represents a crystal of common salt, or sodium chloride. (Fig. 3.) The sodium and chlorine atoms are represented by the colored balls located at the corners of a cube. Various planes exist in such a crystal the distance between the planes being of the order of one hundredth millionth of a centimeter. These cubes form an arrangement of planes from which the X-rays would be reflected, producing the beautiful Laue patterns on the photographic plate. With these preliminary facts before us I feel certain that we will be able to understand better the action of light upon matter.

You are familiar with some of these effects, for example, the action of radiation of certain wave lengths upon the photographic plate causing a change in the atoms of the silver salt used in making the sensitive film. The tanning effect upon the skin of long-continued radiation from the sun or the recently devised ultra violet ray lamps. A very beautiful effect of the ultra violet rays upon certain kinds of matter is known as fluorescence. These radiations of rather short wave length falling upon different materials cause them to fluoresce with great variety of colors. This is an indication that the invisible ultra violet light of short wave length has been transformed into radiation of longer wave length within the visible region of the spectrum.

PHOTO-ELECTRICITY This is the term applied to the electrical effect produced by the action of light upon matter. When a clean surface of one of the alkali metals, sodium or potassium for example, is charged negatively and a positively charged collector is placed nearby, no current passes because of the resistence of the air gap between the electrodes. If now light is caused to fall upon the sensitive metal surface it is found to lose its charge, and a flow of electricity is immediately set up between the metallic surface and the collector acting as the cathode and anode respectively What are the carriers of this electricity?

In the electrolytic cell the electricity appears to be carried by the charged ions of hydrogen and chlorine which collect upon the electrodes. In the ordinary flow of electricity in a conducting wire we believe the carriers to be the free electrons associated with the atom

of matter. The photo-electric action of light takes place in a vacuum, so that the surrounding medium has no effect. Something must emanate from the surface of the metal. The flow of electricity through a rarefied gas as in the neon lamps used for electric signs consists of a stream of electrons negatively charged. The mass of the electron is 8.999×10^{-28} grams. The ratio between the charge (e) and the mass (m) of the electron always has the same value ($e/m = 1.7 \times 10^{7}$ e. m. u. per gram). Such a stream of electrons may be deflected by a magnetic field.

The carriers of the photo-electric current are likewise deflected by a magnetic field and the value of e/m is the same as the electrons. We are therefore led to consider the photo-electric effect as due to the liberation of electrons from the metal surface under the influence of the peculiar kind of radiation falling upon the surface. Ultra violet light has greater effect than the visible light. These liberated electrons pass from the metal plate, the cathode, to the anode and produce a flow of electricity which is dependent upon the light. As the intensity of the light varies so does the resulting photo-electric current. The number of electrons ejected is directly proportional to the intensity of the radiation. The velocity of the electrons, however, increases with the frequency of the light, having a maximum value somewhere in the ultra violet region.

How can light cause the electrons to be torn away from their parent atoms and give to them a velocity of about 300 miles per second?

The accumulation of data of this kind which could not be explained by the wave theory necessitated the development of a modified theory of light. Instead of a continuous flow of radiation from the source the light behaves like a shower of rain. The energy of the beam of light appears to be concentrated into little bundles or quanta of energy called photons.

WHAT ARE PHOTONS?

Not so different from the corpuscles postulated by Newton, but in the ideas of Plank they have been more completely defined. Photons are of different sizes, but no matter whether they be red or violet photons there is a peculiar constant which expresses the relation between the energy of

the photon and the peculiar vibration frequency of something which happens to be associated with it.

This constant is known as Plank's constant h. The energy of the photon E may be expressed as n x h where (n) is the frequency associated with the particular radiation. ($E = n \times h$.)

This quantum of energy has different values depending upon the frequency. Since the value of h is 6.55×10^{-27} erg seconds a photon of ultra violet light of frequency 10^{16} possesses energy of 6×10^{-11} ergs. Other types of radiation differ from this as follows:

Radiation	Frequency	Energy of the Photon
X-rays	10^{18}	6×10^{-9}
Ultra violet rays	10^{16}	6×10^{-11}
Red rays	10^{14}	6×10^{-13}
Infra-red rays	10^{13}	6×10^{-14}

Photons of ultra violet light possess a hundred times more energy than the red photons, and for this reason cause a greater photo-electric effect, cause a greater reaction on the photographic plate, tan the skin and have certain health-producing and germ-killing powers.

The matter in the sun and stars is continually disappearing in the form of radiation which travels through space at the speed of 3×10^{10} centimeters per second. This beam of sunlight contains about fourteen million photons per cubic centimeter, moving along with the speed of light. The energy is localized in the photons. We are fortunate that each photon possesses so little. When the photon hits an atom something must happen. The atom, in a manner which has not been explained, absorbs the energy of the photon (nh) and immediately sends out an electron carrying a negative charge of electricity.

Einstein in 1905 proposed the above explanation and expressed the phenomena in the famous Einstein Photo-electric Equation.

$$1/2\ mv^2 = nh - P$$

The energy P in the equation represents the amount of work required to tear the electron from the surrounding atoms and start it off with a velocity v. When P is equal to nh, the energy of the photon,

no electron will be emitted and no photo-electric effect occurs. Thus we see why light of low frequency will not cause photo-electric emission. The ultra violet light of high frequency causes the greatest photo-electric effect and the elements Lithium, Sodium, Potassium, Rubidium and Cesium of Group I are most easily affected by the light rays. According to the Bohr theory these atoms have one electron in the outer orbit.

Ordinary visible light ejects these outer electrons, the X-rays of much higher frequency may eject electrons from lower levels and the gamma rays from radioactive substances may eject them from the nucleus. The number of electrons and thus the electric current produced is directly proportional to the intensity of the radiation. This is the phenomenon made use of in the photo-electric cell.

WHAT IS A PHOTO-ELECTRIC CELL? On the inner surface of a glass bulb is deposited one of the alkali metals which are very sensitive to light. (Fig. 4.) In the center of the bulb is a collector, the anode, and between it and the metallic surface acting as the cathode a current is produced varying in direct

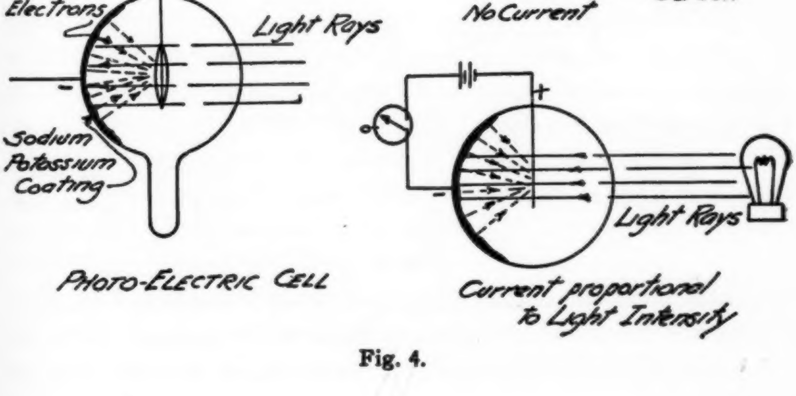


Fig. 4.

proportion to the intensity of the light falling upon the metallic surface. This current is exceedingly small, but can be easily amplified by the use of one or more of the ordinary tubes used in radio amplification.

USE OF PHOTO CELLS

With these simple tubes of varying design we are able to produce some remarkable results. The radio has become so common that we do not appreciate the behavior of these minute corpuscles called electrons. How many of us while sitting in one of our modern theatres listening to the talking pictures give much thought to those electrons which make possible the reproduction of sounds. At a previous lecture I explained the means of production of the talking pictures* I shall try to explain the television.

WHAT IS TELEVISION?

By television we mean the transmission of what is happening at a distance, so that you may receive immediately the impression upon the sense of sight, just as at present you receive the sounds upon the sense of hearing.

The methods in use at the present time depend upon the use of a photo-electric cell which is very sensitive to differences in light value of the object or person being televised. So varied are the differences upon even a small object that it is necessary in some manner to divide

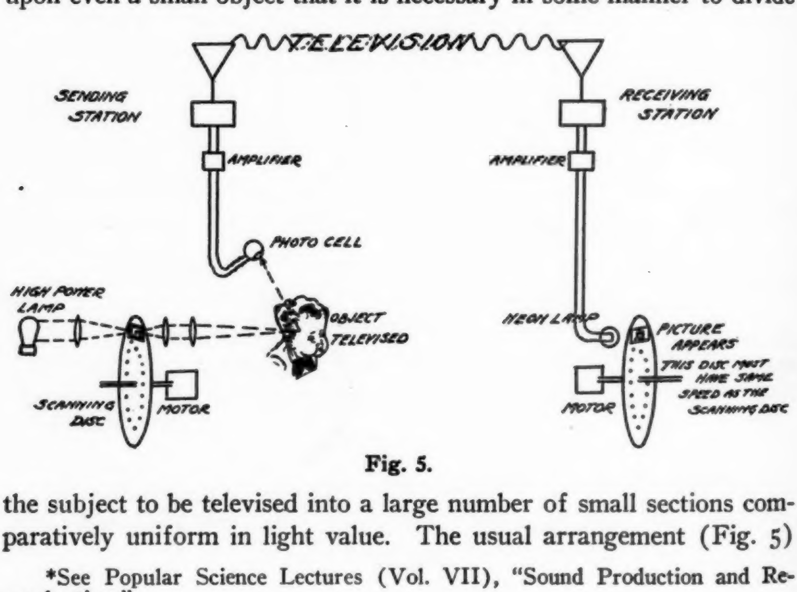


Fig. 5.

the subject to be televised into a large number of small sections comparatively uniform in light value. The usual arrangement (Fig. 5)

*See Popular Science Lectures (Vol. VII), "Sound Production and Reproduction."

is to employ a so-called scanning disc. This disc contains thirty or more holes equally spaced and arranged in a spiral. By causing the disc to rotate at a speed of 750 revolutions per minute a beam of light from a brilliant lamp behind the disc passes very rapidly over every portion of the subject televised. Photo cells suitably arranged react to the varying degree of illumination and send out through the ordinary radio channels a modulated wave which varies in the same manner.

At this speed the entire subject is explored by the spot of light about twelve times per second transmitting this number of composite pictures to the receiving end. If the incoming modulated wave is picked up on the ordinary radio receiving set, a note will be produced in the loud speaker. If instead of the loud speaker, a neon lamp is connected in the circuit, you will observe a fluctuation of the light of the lamp in accord with the changes in light falling upon the photo cells at the sending station.

The receiving set which you will soon have in your home consists of a special neon lamp having a flat rectangular plate which glows with varying brightness as the changes in current are produced by the incoming wave carrying the modulations impressed upon it by the sending station.

In front of this neon lamp and revolving synchronously with the disc at the sending station is a second disc containing the same number of openings arranged in a spiral. As the spot of light scans the object being televised the neon lamp at the receiving end glows with relative brightness to that part of the object scanned. Since a corresponding opening in the disc is now in front of the glowing plate of the neon lamp it will have the same brightness. The rapid succession of such patches of light at this high speed gives the impression of actual observation of the subject televised. The problems of television have been so far developed that I believe that I can predict the broadcasting of important events and the installation of receiving sets in many homes in the very near future. Perhaps it is not too much to predict that coming eclipses of the sun will be televised and broadcast to all parts of the earth.

Photo cells have been used as counters, the passage of an object or person causing the interruption of a light ray and thus producing an effect upon the output of the photo cell. As a burglar alarm or a

smoke detector the operation is similar. Thousands of uses have been found for this cell which only a few years ago was unheard of.

One of the most unique uses to which the photo cell has been put emanates from our own college in the Department of Biology. As a means of observing the effect of various drugs upon the action of the heart, instead of employing rats or other large animals, it was decided to use the daphnia or water flea. This is a rather small animal living in the water, but is very transparent. Under the microscope the heart can be easily observed and the number of heart beats per second can be counted. As a means of keeping a more accurate record and also a permanent one the photo-electric cell was employed. The light shadow of the beating heart is thrown upon a photo-electric cell causing a variation in the output of the cell. By amplification of this current the beating heart can be made to operate a loud speaker, giving an audible record of the heart beats. Any change in the heart beat due to the introduction of a drug upon the microscopic slide will be heard immediately. At the same time the current can be used to operate a moving pointer on a rotating drum, thus producing a permanent record of the changes in the heart beat caused by the various drugs.

Summary

In summing up let me say that our picture of light and matter may be far from the truth. Atoms of matter act as if they consisted of a massive positively charged nucleus associated with exceedingly small negative electrons. When light of certain frequency falls upon matter, the light acts like a shower of rain. The energy appears to be concentrated in the photons acting along the wave which give up their energy and expel an electron when they hit an atom.

Not ony does the light behave sometimes as particles and sometimes as waves, but certain recent experiments appear to indicate the electrons also behave sometimes as particles and sometimes as waves.

Mass of Sun $= 2 \times 10^{27} =$ 2,000,000,000,000,000,000,000,000,000 tons. Energy radiated $= 12 \times 10^{3} =$ 120,000,000,000,000 tons per year.

What Is Light?	What Is Matter:
Properties of Light	*Properties of Matter*
Straight line path	Size
Reflection	Mass
Refraction	Density
Interference	Hardness
Polarization	Elasticity
Photo-electric effect	Gravitation
Etc.	Etc.
Nature of Light	*Nature of Matter*
Corpuscles	Molecules
Waves	Atoms
Photons	Electrons and protons
Waves and particles	Particles and Waves

SYNOPSES OF INFORMATION ON GLYCERIN AND ACETIC ACID

By J. N. Taylor and R. A. Lord

Chemical Division, U. S. Bureau of Foreign and Domestic Commerce, Washington, D. C.

THERE are presented herewith the first of a series of synopses of information, treated from a domestic point of view, covering a number of chemicals, mostly of organic derivation. The subject matter of each report relates to a brief description of the commodity under discussion and its uses, together with statistics of production, export and import. Where available information is given regarding commercial grades, containers and shipping regulations, along with other supplemental data considered of value. Data relative to prices and lists of producers and dealers are not included since these may be obtained by reference to trade journals and trade directories.

In preparing these synopses the writers have drawn freely from authoritative sources, especially from the various publications of the United States Tariff Commission, and the production figures of the Bureau of the Census, and other publications of governmental origin, and also from standard chemical reference books.

Glycerin

Description—Colorless to pale yellow. Liquid. Odorless. Sp. Gr. 1.2604 M. P. 17 degrees C. B. P. 291 degrees C. Soluble in water and alcohol.

Uses—Nitroglycerin and low freezing dynamite compositions, printer's rollers, cosmetics, perfume preparations, rubber stamps, rubber stamp inks, copying inks, fancy toilet and liquid soaps, food preparations, confectionery and candy, fermented drinks, preservative and sweetening foods, flavoring and preserving tobacco, general solvent, litharge and other cements, shoe blackings, hats, preserving cork stoppers from molding, waterproofed paper, parchment, marbled and coated papers, increasing viscosity of liquids, anti-freeze agent in automobile radiators, finishing leather, special lubricant, softening agent in artist's colors, extracting perfumes from flowers, pharmaceutical preparations, glycerophosphates, photographic emulsions, rubber substitutes, plastics, solvent in dyeing and printing textiles, size in making felt and in treating fabrics, demulcent, laxative, antiseptic, emollient, solvent and preservative in medicine.

Production—Glycerin is obtained chiefly as a by-product of the soap and fatty acid industries and recently to a lesser extent from the fermentation of such carbohydrates as molasses. Crude glycerin is produced by a large number of firms who sell their output to the larger manufacturers to be used in the production of refined grades. Important producing centers are New York, Philadelphia, Boston, Buffalo, Chicago, Milwaukee, Cincinnati and Kansas City. The output of glycerin has practically doubled since 1924. Production statistics follow:

Year	Crude, 80 Per Cent. Basis Pounds	Dynamite Grade Pounds	Chemically Pure Pounds
1919	61,792,958	23,635,594	36,692,530
1920	54,688,295	51,571,047	52,859,844
1921	63,946,751	26,944,290	30,322,960
1922	85,337,034	33,907,226	39,912,920
1923	99,578,781	52,368,999	47,992,025
1924	95,153,809	57,363,230	53,242,737
1925	103,406,043	52,658,526	55,447,832
1926	116,369,207	49,579,408	64,459,610
1927	128,208,642	49,265,633	59,126,182
1928	130,498,582	46,621,767	66,419,217
1929	140,041,366	58,981,430	66,790,647
1930	138,647,379	50,377,057	69,654,223
1931*	138,847,219	43,365,948	70,527,961

Imports—The United States has not in the past produced enough glycerin for its own requirements. Prior to the war imports of crude glycerin varied from 30,000,000 to 40,000,000 pounds. Recent imports of crude glycerin are considerably less than that quantity, the decline being large in 1928, but in 1926 and 1927 there was a notable increase in the importation of refined glycerin. Crude glycerin originates chiefly in France and the United Kingdom; refined glycerin principally in Germany and Holland. Import statistics follow:

Calendar Year	Quantity Pounds	Value Dollars
Crude		
1919	3,564,237	417,774
1920	22,272,236	2,912,430
1921	2,603,815	378,319
1922	3,470,988	334,294
1923	14,119,561	2,382,249
1924	13,658,891	1,415,593
1925	18,624,250	2,161,413
1926	26,729,343	3,649,222
1927	13,666,006	2,026,175
1928	3,888,766	282,615
1929	13,681,033	786,598
1930	11,144,193	650,116
1931*	10,152,963	525,099

*Preliminary.

Refined		
1919	39,059	4,471
1920	5,381,737	1,170,030
1921	510,171	95,104
1922	161,358	28,275
1923	585,792	76,994
1924	1,500,644	229,897
1925	2,043,606	305,796
1926	10,839,093	2,328,936
1927	8,288,574	1,697,330
1928	4,217,943	450,247
1929	5,358,498	489,575
1930	3,136,809	265,093
1931*	1,965,535	140,975

Exports—Exports have been small compared with production, except during the war when large quantities were shipped for military purposes. They have been less than 1 per cent. of production, except in 1928, when they were nearly 2 per cent. The best foreign markets are Chile, Mexico, Canada, Cuba, Argentina, Philippines and Brazil. Export statistics follow:

Year	Pounds	Value
1922	2,870,465	$425,891
1923	1,767,407	318,765
1924	1,415,882	237,639
1925	1,367,191	282,078
1926	767,698	192,220
1927	693,144	143,700
1928	2,051,937	259,100
1929	1,375,605	197,986
1930	607,690	102,892
1931	328,143	48,095

Grades—The chief commercial grades are (1) crude soap lye; (2) crude saponification; (3) C. P. (chemically pure); (4) dynamite; (5) yellow distilled.

Containers—1,000 500 pound drums; 450 pound barrels; 50, 25, 10 pound cans; 10, 5, 1 pound bottles.

Trade Association—Association of American Soap & Glycerin Producers, Inc., 45 East Seventeenth Street, New York, N. Y.

Acetic Acid

Acetic Anhydride

Description—Acetic acid is a colorless liquid soluble in water, alcohol and ether.

Uses—More than half of the total consumption of acetic acid calculated on a 100 per cent. basis is in the manufacture of solvents

*Preliminary.

for pyroxylin lacquers. About 7 per cent. is consumed in the manufacture of cellulose acetate silk and twice this amount in textile dyeing and finishing. Other important uses are in the manufacture of white lead and in the preparation of chemicals and dyes.

Acetic anhydride, formerly used principally in the production of aspirin, has recently become of increasing importance in the manufacture of cellulose acetate silk and films.

Production—Acetic acid is derived principally from two sources: (1) Acetate of lime obtained in the distillation of hard wood, and (2) synthetically, from calcium carbide. Formerly our entire supply of acetic acid was obtained from acetate of lime which was on a large export basis. The production of acetic acid from carbide began in 1927, and there are now three firms producing by a synthetic process in the United States. There were seventeen firms reporting production in 1929 located in Pennsylvania, New Jersey, Massachusetts, Michigan, California, Illinois, Indiana, Maryland, New York and Tennessee. Production * of acetic acid for the years 1909-1929 follows:

Year	Dilute	Glacial Pounds	Total Pounds	Value
1909	....	....	**58,000,602	$
1914	....	....	**75,303,375	
1919	42,248,803	20,131,487	62,380,290	
1921	23,530,087	**15,544,157	**39,074,244	
1923	29,470,045	**32,663,200	**62,133,245	4,154,838
1925	29,824,953	35,020,394	64,845,347	4,437,622
1927	41,399,599	15,815,347	57,214,946	5,049,285
1929	72,737,771	13,449,259	85,780,056	6,890,411

The production of acetic anhydride for sale in the United States in 1925, the latest available year, was 2,088,567 pounds. Production, in recent years, has undoubtedly exceeded that figure.

Imports—Imports of acetic acid originate almost entirely in Canada, where a large plant produces the synthetic acid from carbide. Imports in the years 1928-1929 are largely accounted for by the rapid increase in production of pyroxylin lacquers and of cellulose acetate silk in 1929, a shortage of acetic acid necessitated increased imports of acetate of lime. Imports for consumption of acetic acid into the United States follow:

*Does not include synthetic product, for which production figures are not publishable. Production, however, was about the same in 1930 as in 1929, but the unit value of sales decreased about 17 per cent.

**Includes acetic anhydride.

	Acetic Acid Containing by Weight— Not More Than 65 Per Cent. Acetic Acid		More Than 65 Per Cent. Acetic Acid	
	Quantity Pounds	Value	Quantity Pounds	Value
1923	37,052	$ 4,758	664,034	$ 79,553
1924	371,732	27,080	1,202,765	144,003
1925	362,214	29,130	3,059,185	232,950
1926	6,026,859	289,282	1,995,982	232,855
1927	6,766,512	350,421	3,874,504	454,382
1928	12,163,499	644,816	6,058,077	728,739
1929	21,410,253	1,289,002	7,824,521	727,847
1930	12,069,687	586,873	10,307,317	911,541
1931*	6,113,780	201,219	9,177,750	601,587

Imports of acetic anhydride are small. In 1928 they amounted to 8903 pounds, valued at $1701; in 1929, 79,452 pounds, worth $21,319; in 1930, 372,707 pounds, worth $57,033, and in 1931, 111,259 pounds, worth $17,226.

Exports—Exports since 1922 have been less than a million pounds annually. The distribution of the 1928 exports of 298,333 pounds, valued at $41,894, to the leading markets was as follows: Cuba, 86,804 pounds, $10,184; Mexico, 46,894 pounds, $6971; Canada, 36,602 pounds, $7390; Venezuela, 28,672 pounds, $3936; Union of South Africa, 25,000 pounds, $1283; Peru, 18,811 pounds, $2609. Statistics of exports of acetic acid during 1929, 1930 and 1931 are not available, but these shipments are believed to have been negligible owing to the large expansion in the domestic consumption. Acetic anhydride is not listed separately in our export statistics.

Grades—Twenty-eight per cent., 56 per cent., 70 per cent., 80 per cent., pure; 80 per cent. technical; glacial (99.5 per cent.); U. S. P. dilute; U. S. P. glacial.

Containers—400,450 pound barrels; 100 50 pound carboys; bottles of various sizes.

Trade Associations—Synthetic Organic Chemicals Manufacturer's Association, 1 Madison Avenue, New York.

*Preliminary.

PHILADELPHIA—THE FIRST MEDICAL CENTER IN THE BRITISH COLONIES

By Francis Randolph Packard, M. D.

THE city of Philadelphia was founded at a much later date than Boston and New York, and its great founder, William Penn, profited by the experience of the earlier English settlements. As the Quakers rejected what they termed a "howling ministry" there was never any "angelical union" of divinity and physick, such as Cotton Mather termed the combination of sacerdotal with medical functions on the part of the ecclesiastical order in New England. Three well-trained physicians, Griffith Owen, Thomas Wynne and Thomas Lloyd, came over with William Penn in 1682. From an early date young men who intended to practice medicine, after serving an apprenticeship with a practitioner in Philadelphia, went abroad to complete their education. Thomas Cadwalader followed this procedure, studying under the great Cheselden in London, and on his return to Philadelphia in 1730 or 1731 gave demonstrations in anatomy to his Philadelphia colleagues. Philadelphia's most prominent citizen, Benjamin Franklin, spent many years in London, where he was on intimate terms with Drs. John Fothergill and John Coakley Lettsom, two of the most distinguished physicians of that city. He acted as a liaison officer between the young men who went abroad, and the great teachers of the day in London and Edinburgh. The first hospital founded in the Colonies was the Pennsylvania Hospital, in Philadelphia, which began its beneficent career in 1751. Its first staff, Thomas Bond, Phineas Bond and Lloyd Zachary, had all studied medicine abroad. When the College of Philadelphia, now the University of Pennsylvania, established the first medical school in the Colonies in 1765, its first two professors, John Morgan and William Shippen, Jr., were both graduates of the medical school of the University of Edinburgh, and in subsequent years, as the faculty was enlarged, Adam Kuhn, Benjamin Rush, Philip Syng Physick and Caspar Wistar, had all of them received the degree of M. D. from the same institution. With a first-class hospital, which from the beginning of the medical school offered its clinical facilities to the faculty and students, all of the men mentioned above, being on the staff of the hospital, as well as teachers in the medical school, no wonder Philadelphia could afford opportunities for the study of

medicine, unobtainable elsewhere in the Colonies. It was not until some years after the Revolution that hospitals and medical schools were finally established in Boston and New York. A medical school had been opened at King's College, New York, in 1767, but it was disrupted by the Revolution, and only permanently re-established as the medical department of Columbia College, the successor to King's in 1787. A medical school was not established at Harvard until 1787. The character of the profession in Philadelphia was also notable for its high ethical standards. The men who had most to do with the hospital and medical school were cultured gentlemen of high social standing in the community, and the ideals they instilled into the students who flocked to study under them did much to maintain for many years the distinguished position of Philadelphia in the medical world.

HISTORICAL NOTE ON GLYCERIN*

By Joseph W. England, Ph. M.

THE story of glycerin is of rich historical interest. Although discovered by Scheele in 1779, it was not made in this country, at least, until 1846 and not sold, commercially, until 1848. It was first made by Robert Shoemaker, whose laboratory was located at the southwest corner of Second and Green Streets, in Philadelphia, as the result of a request by Professor William Procter, Jr., for a "specimen" of glycerin to exhibit to his classes at the Philadelphia College of Pharmacy. After supplying the specimen, the practical-minded Robert Shoemaker—for many years a member, trustee and officer of the college—believed he saw commercial possibilities in the sale of this product. His first sale was to Professor Edward Parrish on June 1, 1848, then in the retail drug business at the northwest corner of Chestnut and Ninth Streets in Philadelphia, adjoining the buildings of the University of Pennsylvania. The price was $4 per pound. Today the price of glycerin in large quantities is about eleven cents per pound.

Through the courtesy of Mr. Walter E. Wright, Philadelphia manager of the Harshaw Chemical Company of Cleveland, Ohio, large manufacturers of glycerin, I have received the following data:

"In 1779 the Swedish chemist, Karl Wilhelm Scheele (1742-1786) observed the presence of a sweet-tasting substance in the liquid resulting from the action of litharge on olive oil in the preparation of lead plaster. In the course of further investigation he found that on similar treatment other oils and fats, including butter and lard, yielded the same material. Scheele also noted that although this substance could be obtained as a syrupy fluid, possessed a sweet taste like sugar and yielded oxalic acid on oxidation, yet it could not be fermented and in many respects differed markedly from sugar or any chemical compound then known.

"He thus describes his investigations in a communication which appeared in the Transactions of the Royal Academy of Sweden in 1783:

" 'It is not generally known that all fats obtained by pressure contain a natural sweet principle which differs in its special rela-

*Presented to Pennsylvania Pharmaceutical Association, June 21-23, 1932.

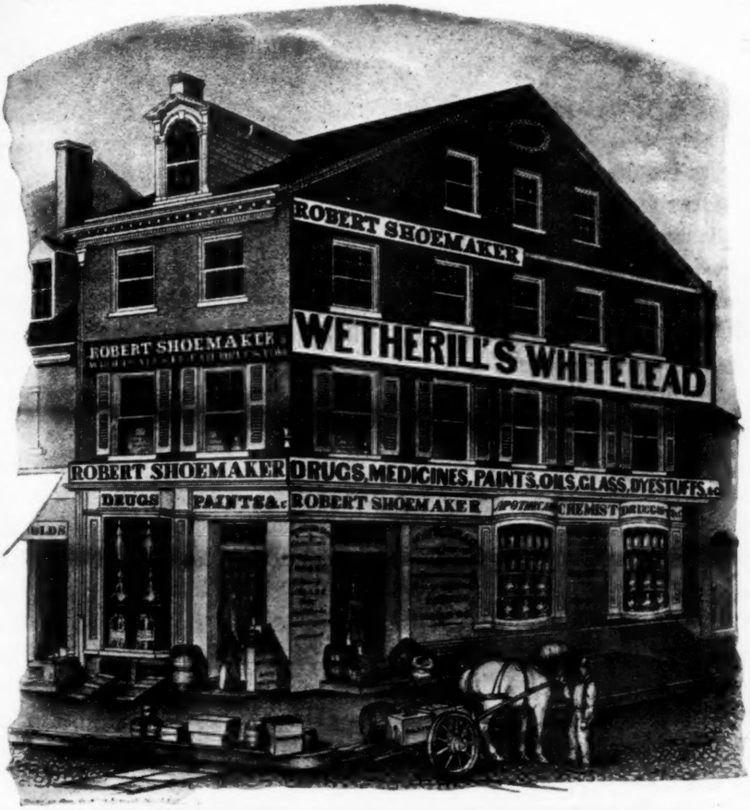
tions and properties from the other well-known saccharine materials occurring in the vegetable kingdom. This sweet principle makes its appearance when oils of this kind are boiled with litharge and water until the whole of the litharge is dissolved by the oil. Water is then poured upon the "emplastrum simplex" thus formed, the whole boiled for a few minutes, and on cooling the liquid is filtered off from the plaster and boiled until the residue becomes syrupy.'

"Because of its physical properties Scheele gave to this new substance the name 'sweet-oil'—Oelsuss—although it was variously referred to as 'fat-sugar,' 'oil sugar,' etc. He was unable to determine its composition or its exact relation to the oils and fats from which it was obtained and to the lead plaster accompanying its formation.

"It remained for the French chemist, Michel-Eugene Chevreul (1786-1880) to shed further light on this product of the saponification of oils and fats. His researches during the period from 1811 to 1823 showed conclusively that the substance discovered by Scheele was present in all oils and fats as an organic base in combination with various organic acids. He found that the organic base was set free when the oil or fat was treated with lead oxide, lime or an alkali. In 1814 Chevreul gave to this organic base the name 'glycerine'—Greek: sweet—and made extensive investigations as to its chemical constitution and decomposition products. In addition he pointed out that glycerin was present in large quantities in the waste liquors from soap and candle factories.

"Investigations as to the composition of glycerin were carried on by Pelouze, Wurtz and Berthelot, and as a result of the work by these men the chemical formula and constitution were established in 1836. The complete synthesis of glycerin from its chemical elements was afterwards effected by Friedel in collaboration with Silva."

Little, in 1848, did the Quaker pharmacist, Robert Shoemaker (1817-1897), who was one of the most beloved of all Philadelphia pharmacists of his time, dream of the tremendous developments that were destined to follow in the wake of his modest adventure into the American manufacture of glycerin, for glycerin has become of vast industrial importance, not only in medicine, pharmacy and chemistry, but also in the whole industrial field. Later, in 1879, he referred to these developments in a most interesting article on "Glycerin



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Has constantly on hand, and offers for Sale Wholesale and Retail,

WHITE LEAD,
Warranted pure, at Manufacturers' prices.
Paints of all Colors,
Dry or Ground in Oil.
COPAL, COACH, BLACK, & WHITE
VARNISH.
Linseed Oil, in Casks or by Retail.

FRESH AND GENUINE
Drugs and Medicines,
Chemicals, Perfumery, Surgical Instruments.
Thomsonian Medicines.
Spices, Indigo, Sal Soda, Sal Eratus,
POTASH.
Wall Colors, Camels' Hair Pencils, &c. &c.

WINDOW GLASS,
all sizes & qualities, by the box or single light.
Picture Glass,
Fitted to Frames, or cut to irregular sizes.
PLATE GLASS,
Cheap Glass for Hot Beds, Cellars, &c. &c.
Demijohns, Carboys, &c.

Country Merchants, Physicians, and others, supplied at very low prices, and every article sold will be warranted genuine.

R. S. is sole proprietor and manufacturer of "Shoemaker's Rheumatic and Strengthening Plasters."

The first glycerin in America was made by Robert Shoemaker, whose laboratory was located at the southwest corner of Second and Green Streets in Philadelphia, as the result of a request by Professor William Procter, Jr., for a "specimen" of glycerin to exhibit to his classes at the Philadelphia College of Pharmacy. After supplying the specimens, the practical-minded Robert Shoemaker—for many years a member, trustee and officer of the College—believed he saw commercial possibilities in the sale of this product. His first sale was to Professor Edward Parrish on June 1, 1848, then in the retail drug business at the northwest corner of Chestnut and Ninth Streets in Philadelphia, adjoining the buildings of the University of Pennsylvania. Today, the price of glycerin in large quantities is about 11 cents per pound.

—Its Early Manufacture in This Country," published in the American Journal of Pharmacy (June, 1879, 289), from which the following abstract has been taken:

"In the year 1837 I commenced, in this city, the preparation of the plasters of the U. S. Pharmacopœia, and sold them (chiefly in rolls of half a pound) to the druggists in this city, first, and afterward throughout the country. Machine spread plasters (except adhesive, on cloth) came later, and I may have something to say of these in a future paper.

"The base of all, or nearly all, of these plasters was emp. plumbi, of which I manufactured large quantities.

"About the time my late much-esteemed friend, Wm. Procter, Jr., was preparing the matter for his 'Mohr, Redwood and Procter's Pharmacy,'* he asked permission to examine my apparatus for the manufacture of lead plaster, with a view of writing an article for his forthcoming book. This request I freely granted, and the result of his visit to my laboratory may be found on page 420, etc., of that book, edition of 1849. At the time of the visit of Mr. Procter we were busily engaged in dipping out the newly made emp. diach., and cooling it by kneading and pulling in cold water. This water, when it became warm, was allowed to run to waste, carrying with it what glycerin it had extracted from the plaster.

"Mr. Procter asked me if I could not make him some glycerin, 'at least enough for a specimen for the class,' adding, 'here is a great waste.' I had often tasted the water sweetened by the glycerin, but as there was at that time no demand for the article, this 'waste' was allowed.

"I at once set about producing the specimen for Professor Procter. As near as I can remember, taking about five gallons of water in which lead plaster had been kneaded and cooled, I turned it into an evaporating pan (jacketed), passed on the steam, keeping it below the boiling point, evaporated the fluid to the consistence of a thin syrup. Transferring this to a glass vessel, a current of sulphuretted hydrogen was passed through it, to precipitate the oxide of lead held in solution, then filtered it, and my glycerin was completed. Of this, my first effort, I sent Mr. Procter a part, retaining the balance, which was often shown as a curiosity.*

*Original sample of Procter's in safe of Philadelphia College of Pharmacy and Science (J. W. E.).

"This was about the year 1846. Although glycerin had been discovered by Scheele more than sixty years before that time, it had not come into use (at least in this country), and there was no demand for it.

"After this (about 1848) I made a larger quantity, it having been recommended in a French medical journal as a curative in pulmonary affections. The paper was translated, and appeared in one or more of our medical journals; it came to be prescribed by some of our physicians.

"Looking back over my books, I find the first entry charging glycerin under date of "6th mo. 1st, 1848," and this was to Edward Parrish, then at the northwest corner of Chestnut and Ninth Streets. The quantity was small, only ¼ lb., and the price charged was $4.00 per lb. The next sale was to a New York house, at same price, and for a larger quantity. The entire product sold in 1848 was about 15 lbs. In 1849 I reduced the price to $3.00 per lb., and it remained steadily at this figure until near the close of 1850, when it fell to $2.75. The quantity sold in 1849 was about 200 lbs. The demand rapidly increased, and in 1850 the quantity sold was much larger, but I find no charge at a less price than $2.70 per lb.

"I find sales entered to druggists (besides those in this city) in New York, Boston, Providence, Baltimore, Louisville, New Orleans, etc. The greatest demand, however, came from our own wholesale houses, the manufacturing chemists being the largest buyers. Glycerin now began to be imported from England (Price's), and sold at a price below what it cost me to produce it, and so I gradually ceased to make it. This English article was made from 'soap liquor.'

"It is an interesting study, comparing the small beginnings as related above (only a generation back) with the immense production of glycerin at the present day. So far as I am informed, all that I made and sold was used medicinally, either internally administered or in form of lotion or unguent.

"At this day (1879), vast quantities are used in the manufacture of nitroglycerin, dynamite, dualin and other explosives. The perfumers are large consumers, also the confectioners. Large quantities are used for the preservation of fruits and meat, as well as in the preparation of chewing tobacco.

"But the greatest demand comes, perhaps, from the brewers. It is estimated that over 40,000 pounds is drank annually in beer in this country alone; and instead of my old price of $4.00 per lb., an article quite as good can now be produced for 18 cents per lb."

Thus, in 1846, William Procter, Jr., the father of American pharmacy, called the attention of his friend Robert Shoemaker to the "waste" of glycerin in the manufacture of lead plaster, and thus the practical minded Robert Shoemaker in 1848 commenced the manufacture and sale of glycerin in this country, the production of which, today, runs into thousands of tons annually.

During the past half century the commercial importance of glycerin has enormously increased. Today it is used not only in the medical and pharmaceutical worlds, but also in cosmetics, soaps, pastes, flavorings, food products, antifreeze mixtures, and a very large number of derived chemical compounds and products for industrial and technical application. In fact, so great have been the developments in the use of glycerin in the industrial and technical world that volumes could be written on the subject.

THE ONE HUNDRED AND TENTH ANNUAL COMMENCEMENT OF THE PHILADELPHIA COLLEGE OF PHARMACY AND SCIENCE

THE alumni reunion at the Philadelphia College of Pharmacy and Science, June 7th, was featured this year by an old-time minstrel show. Members of the cast included several stars from the former Dumont's Minstrels, which entertained Philadelphia audiences for many years.

Special guests of honor at the Philadelphia College alumni reunions are the graduates who are celebrating the fiftieth anniversary of their graduation. The minstrel show was presented particularly in their honor because these alumni in their undergraduate days at the Philadelphia College had been steady and enthusiastic patrons of the minstrel shows then so popular in Philadelphia. The minstrel show was recreated with many of the original actors to bring back to them some of the memories of their college days.

The graduates celebrating the semi-centennial this year were the class of 1882. Among those present from this class were:

Dr. Virgil Coblentz, chemist and author, Long Branch, New Jersey.

Joseph M. Fronefield, Jr., realtor, Wayne, Pennsylvania.

Josiah K. Lilly, chairman, Eli Lilly & Co., Indianapolis.

Alexander Macalister, physician, Camden, New Jersey.

William H. May, Egg Harbor, New Jersey.

Dr. B. Franklin Scholl, physician, Philadelphia.

Harry R. Stallman, retired pharmacist, Norristown, Pennsylvania.

Frederick W. E. Stedem, pharmacist and drug journal contributor, Philadelphia.

Judson Thomas, pharmacist and civic leader, Scranton, Pennsylvania.

Dr. John A. Lambert, physician, Indianapolis.

Herman E. Thoms, pharmacist, Indianapolis.

Three talented vocalists among the faculty of the Philadelphia College were included in the cast of the minstrel show. They were Dr. Adley B. Nichols, 1918, and Ralph L. Calvert, 1921, both assistant professors of pharmacy, and Lee G. Cordier, 1921, who is assistant professor of chemistry. The reunion of the semi-centennial class was

also the occasion of the presentation to them of certificates as semi-centennialists denoting fifty or more years of service in their chosen profession.

Josiah K. Lilly responded for the semi-centennialists and expressed the hope that future reunions of his class would be as enjoyable and inspiring as this one had been.

On the afternoon of Alumni Day, the annual meeting of the Philadelphia College Alumni Association was held. The following officers were elected:

President—Dr. Lewis C. Scheffey, 1915.
First Vice-President—Joseph W. E. Harrisson, 1917.
Second Vice-President—Frank N. Moerk, 1913.
Recording Secretary—Joseph W. England, 1883.
Corresponding Secretary—John E. Kramer, 1925.
Treasurer—Brua C. Goodhart, 1907.

Ivy planting and placque placing were conducted out of doors on the college grounds, alumni reunion day. President Raymond E. Fitzgerald, of the graduating class, presented the placque and ivy on behalf of that class. George A. Brindle then delivered the graduating class ivy day oration. The placque and ivy were accepted by President Wilmer Krusen with appropriate remarks in the presence of the graduating class and a large group of visiting alumni.

The following alumni also made presentations of placques on behalf of their classmates:

Richard H. Lackey, 1887, Philadelphia College trustee.

George H. Kramer, 1897, father of John E. Kramer, 1925, Philadelphia College registrar.

Quintus Hoch, 1899, long active in the affairs of the Alumni Association.

Adley B. Nichols, 1917, pharmacy professor at the Philadelphia College.

The alumni banquet followed, at which nearly 300 alumni were seated in the college auditorium. One of the features of the alumni banquet was a special table for pharmacy graduates of the former Medico-Chirurgical College, now merged with the Philadelphia College. Thirty graduates of Medico-Chi were present. Dr. George W. Meeker was spokesman for this group and was presented by W. Wilson McNeary, 1907. Dr. McNeary was introduced to the guests at the banquet by Mrs. Charles H. LaWall, Philadelphia Col-

lege graduate of 1904, and retiring president of the Alumni Association. She acted as toastmistress. Other Medico-Chi alumni who spoke were the former deans, Dr. I. V. S. Stanislaus and Dr. Julius W. Sturmer. Dr. Robert P. Fischelis, 1911, and Brua C. Goodhart, 1907, also spoke for Medico-Chi.

On behalf of the Philadelphia College class of 1887, Henry K. Mulford announced that his class is arranging to present another mural in the series adorning the walls of the college library.

Other alumni present who spoke were Clarence W. Elston, 1892, George H. Kramer, 1897; John Alexander Borneman, 1902; Robert G. Reynolds, 1907; Elmer H. Hessler, 1912; Ralph R. Foran, 1917; Aaron Lichtin, 1922, and for the graduating class, Louis Slutsky.

Following the minstrel show in the evening, an informal dance concluded the day's entertainment.

At the 110th annual commencement of the Philadelphia College of Pharmacy and Science, held at the college June 8th, two men prominent in professional and scientific work were honored with the degree of Master of Pharmacy.

One of the recipients was George A. Gorgas, 1881, graduate of the Philadelphia College, and for forty-nine years a retail pharmacist in Harrisburg, Pennsylvania. He is president of the George A. Gorgas Drug Company, which operates four drug stores in Harrisburg, and has been active throughout his career in the Pennsylvania Pharmaceutical Association and the American Pharmaceutical Association. He is also prominent in civic and fraternal affairs in Harrisburg.

The other recipient of an honorary degree was John G. Roberts, of Philadelphia, who is nationally known for his development of methods of detecting impurities in crude drugs. He is a 1906 graduate of the Philadelphia College and has been associated for many years with the Smith, Kline & French Laboratories in Philadelphia.

John H. Webster, of Detroit, also was to have received an honorary degree, but was unable to be present. The degree will be conferred upon him at the next exercises.

In addition to these honorary degrees, 193 degrees in course were conferred upon students from virtually every part of the United States and some foreign countries. Degrees were granted in pharmacy, pharmacognosy, bacteriology and chemistry.

Of the graduates, one received the degree of master of science in chemistry, one master of science in pharmacognosy, nine bachelor

of science in chemistry, twelve bachelor of science in pharmacy, three bachelor of science in bacteriology, four pharmaceutical chemists, and 147 graduates in pharmacy.

Students who completed special courses and qualified for certificates (not including those receiving degrees) included one each in industrial chemistry, sanitary chemistry and organic chemistry, and five in bacteriology and eight in clinical chemistry.

Degrees were conferred on the following:

MASTER OF PHARMACY (Honoris Causa)

George Albert Gorgas
John Griffith Roberts
John Hugh Webster

MASTER OF SCIENCE IN CHEMISTRY

Leon Elmer Hunter

MASTER OF SCIENCE IN PHARMACOGNOSY

Elsie Mary Klenke

BACHELOR OF SCIENCE IN CHEMISTRY

John Ferrante
Vincent Henry Gattone
Joseph Charles Haefelin
Abner Irving Kayser
William Kazanjian
Edward Wheeler Meeker
Allen Frederick Peters
Philip Augustine Romano
Martin Schiffer

BACHELOR OF SCIENCE IN PHARMACY

Walter John Bedini
Russell Edward Brillhart
Wah Kan Chock
Jeanne Dorothy Dreier
Roy Scheffly Koch
George Amedeo Mascieri
John Neumann McDonnell
Harry Richman
Carl Henry Ruopp
Charles Henry Schaeffer
Sol Shapiro
Raymond Leonard Zielinski

BACHELOR OF SCIENCE IN BACTERIOLOGY

Alexa Mary Czechowicz
T. Geneva Dennis
Ignatius John Yankevitch

PHARMACEUTICAL CHEMIST

Lane Verlenden Collins, Jr.
Henry Clay Elder, Jr.
Sigmund Moerman
Frida Wente

CERTIFICATE OF PROFICIENCY IN INDUSTRIAL CHEMISTRY

Robert Charles White, Jr.

THE DEGREE OF GRADUATE IN PHARMACY

Joseph Anthony Acinapura
Willard Brown Allen
Charles Edward Anthony
Carl Leon Apgar, Jr.
Harry Nathaniel Arch
William Chauncey Bennett

William James Berkley
Earl Hummel Bitting
Lenore Bonelli
Elwood Thomas Bracey
Lees Corley Braddock
Gerald Michael Brennan
George Andrew Brindle
Samuel Leavitt Brown
Emanuel Edward Buch
Benjamin Buchalter
Maria del Carmen Capella
John Albert Carugno
Isabel Irene Clark
John Andrew Conner
George Romaine Converse
John Gregory Cverko
Rocchina DeBartolomeis
Sarah Martha DeBartolomeis
Donald Sheldon Deibler
John Thomas DePietro
Stephen Derkach
Emidio Joseph DiCarlo
Maurice Norman Docktor
John William Dolinsky
Willard Evan Edwards
Alexander Egudin
Adolph Max Eisenberg
Edwin Kemmerer Eisenhart, Jr.
Theodore Ellis
Sheldon Wade Evey
Albert Joseph Feicht, Jr.
Robert Henry Ferris
Harriet Bell Finney
Raymond Edward Fitzgerald
Horace James Fleetwood
Sidney Fomalont
Rudolph Fox
Simon Frank
Emil Wilkins Gallagher
Nelson Day Gayman
Saul Joseph Gold
Nathan Goldman
Harry David Goldstein
Samuel Milton Gottlieb
Abraham Gratz
Sol Isadore Green
Josef Greenfield
Irene Gutowski
Charles Elmer Heuston
Bertham Robert Hill
Harry Mulford Hitchner
Milton Thomas Hysore
Mary Ida Immediata
Ralph Davis Jackson
John Henry James
LeRoy Thomas James
Mary Angeline Jurkowski
Isadore Saul Kancher
Marie Kathryn Kavanagh
Eunice Kavjian
John Calvin Keiter
Hugh Patrick Kelly
Robert Henry Kennedy
Joseph Horst Kershner
Benjamin Klebanoff
Harry Edward Kolb
David Kovelman
Abraham Krigstein
Francis Kurlancheek
Harry Aaron Lamm
Milton Lebedensky
Joseph Hawley Leeke
Raymond Jacob Loos
Irwin Morton Lupin
George Warren MacFarland
Walter Joseph Mahoney
Joseph John Maloney
Alton Delmont Mann
Marino Joseph Martella
Anthony Francis Matukaitis
Joseph Albert McCarty
Adeline Marie Miceli
Paul John Milano
Lester Oscar Moore
Paul Grim Morrow
Glenn Urban Mumma
Fannie Nadel
Joseph Walter Nedzinski
Benjamin Nusbaum
Jacob Sigmund Perloff
Amato Louis Pescatore
Jacob Worth Pickel
Morris Pollon
Julian Joseph Portenar

Joseph Pressman
Israel Edward Pritzker
Jacob Resnick
Robert McWilliams Rice
Mary Rose Rogers
Don Alois Rommelt
Nathan Rosenthal
Paul Herman Rudberg
Louis Harrison Russock
Isadore Sadel
Edward George Sakalosky
Jack Noah Sandman
Otto Karl Seidel
James Vincent Scarro
George William Sheriff
Walter Chester Shipcuskie
Merrill Vincent Shoemaker
Harvard Shoostine
Hershel Silas
Louis Slutsky
Robert Wells Smith
Bernard Syndman
Robert Maurice Solsky
Jacob Sosnovsky
James Squillace
Percy John Starkey
Solomon Willick Steigman
Robert Row Stevenson
Elizabeth Heaney Sylvester
Samuel Taflin
Albert Franklin Tice
Cyrus Solomon Topkis
George Homer Trapp
Samuel Isadore Uniglicht
Bruno James Vangeli
Berl William Wager
Irvin Robert Waller
Edith Ruth Weiss
Norman Weiss
Hervey Merton Wendle
Benjamin Stanton Willig
Richard Herman Wilson
Paul Lawrence Wood
Walter Yushchik
David Zabinsky
Betty Mitzi Zahn
Israel Herman Zebooker

CANDIDATES WHO COMPLETED SPECIAL COURSES AND QUALIFIED FOR CERTIFICATES

(This does not include students who completed courses in these subjects for credits for a degree)

Certificates in Bacteriology

Mary Magdelene Connor
Walter James Gaskell, P. D.
Mildred Sbar
Pincus Shub
Harry Segel

Certificates in Clinical Chemistry

Yetta Calika
Reuben Elfman
Walter James Gaskell, P. D.
Rose Rosenthal
Mildred Sbar
Pincus Shub
Harry Segel
Lenore Bonnelli

Certificate in Sanitary Chemistry

Walter James Gaskell, P. D.

Certificate in Advanced Organic Chemistry

Joseph Gessner

Award of Prizes 1932

GRADUATES IN PHARMACY (Ph. G.)

Designated as "Distinguished"

With General Average Over 92%

Louis Slutsky

Designated as "Meritorious"

With General Average Between 88% and 92%

George Andrew Brindle	David Kovelman
Benjamin Buchalter	Abraham Krigstein
Miss Rocchina DeBartolomeis	Morris Pollon
Albert Joseph Feicht, Jr.	Israel Edward Pritzker
Sidney Fomalont	Jack Noah Sandman
Charles Elmer Heuston	Otto Karl Seidel
Milton Thomas Hysore	Hershel Silas

The Procter Prize, a gold medal for the highest average of the class, is awarded to:

Louis Slutsky

The William B. Webb Memorial Prize, twenty dollars and a bronze medal for the highest general average in the branches of Operative Pharmacy, Analytical Chemistry and Pharmacognosy, is awarded to:

Louis Slutsky

Honorable Mention to

Miss Rocchina DeBartolomeis	Abraham Krigstein
Sheldon Wade Evey	Paul John Milano
Charles Elmer Heuston	Jack Noah Sandman

Hershel Silas

The Frank Gibbs Ryan Prize, a gold medal endowed by the Class of 1884, as a memorial to their distinguished classmate, for the best average in the Chemical and Pharmaceutical Laboratory Courses, is awarded to:

Louis Slutsky

Honorable Mention to

Charles Edward Anthony	Raymond Jacob Loos
Miss Rocchina DeBartolomeis	Jack Noah Sandman
Abraham Krigstein	Miss Elizabeth Heaney Sylvester

The Maisch Botany Prize, a special prize of twenty dollars in gold, offered by Sinclair S. Jacobs, of the Class of 1909, to the member of the graduating class who shall have presented the best herbarium collection of plants, or the best thesis on the microscopical structure of medicinal plants, is equally divided between:

Josef Greenfield   Adolf Max Eisenberg

The REMINGTON MEMORIAL PRIZE, twenty dollars, offered by the Estate of Joseph P. Remington, for the highest average in the examinations of Operative Pharmacy and Dispensing, is awarded to:

JACK NOAH SANDMAN

Honorable Mention to

Miss Rocchina DeBartolomeis — Marino Joseph Martella
Milton Thomas Hysore — Louis Slutsky

The MAHLON N. KLINE THEORETICAL PHARMACY PRIZE, a Troemner Agate Prescription Balance, offered by the Mahlon N. Kline Estate, for the highest average in Theory and Practice of Pharmacy, is awarded to:

MILTON THOMAS HYSORE

Honorable Mention to

Marie Kathryn Kavanagh — Hershel Silas
Louis Slutsky

The FREDERICK WILLIAM HAUSSMANN MEMORIAL PRIZE of one hundred dollars, given to the Pharmacy student with the highest average for the last three years of the course, is awarded to:

LOUIS SLUTSKY

Honorable Mention to

Miss Rocchina DeBartolomeis — Jack Noah Sandman
Abraham Krigstein — Hershel Silas

The LAMBDA KAPPA SIGMA PRIZE, a Sorority Key, to the Sorority member in the Ph. G. Class attaining the highest average during the Senior year, is awarded to:

MISS ROCCHINA DEBARTOLOMEIS

And the Sorority Key to the member making the highest average in the Senior year of the Bachelor of Science Course is awarded to:

MISS ALEXA MARY CZECHOWICZ

Gold Medals awarded by the Alumni Association to the student of the Ph.G. Class and to the student of the B. Sc. Class who attain the highest scholastic averages, are awarded to:

Ph. G. ....LOUIS SLUTSKY
B. Sc. ....EDWARD WHEELER MEEKER